THE HETEROGENEOUS NETWORK OF FUNCTIONAL FOOD TECHNOSCIENCE, PRODUCTIVE RISK AND IMPURE NATURE

BY

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DISSERTATION

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Sociology
in the Graduate Collge of the
University of Illinois at Urbana-Champaign, 2011

Urbana, Illinois

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ABSTRACT

This dissertation analyzes increasing interests in health risks and natural foods since the late 1990s by investigating the emergence of the concepts of functional food and lifestyle-related disease. For this project, I conducted on-line multi-sited ethnographic study to examine and examined the connections among food science, molecular biotechnoscience, the mass media and on-line communities formed around a specific brown rice variety with enhanced amount of GABA (gamma aminobutyric acid). I also conducted interviews with five Korean scientists who are actively involved in functional rice development. This research focuses on the processes through which biotechnoscience, the mass media and increasing consumers' interests in natural foods constitute three major changes in risk society; (1) changes in the conventional boundary between natural and artificial foods, (2) between esoteric and exoteric circles as knowledge producers, and (3) between the mainstream biomedical practices and dietary intervention for health management.

Germinated Brown Rice (GBR) has been advertised as a functional food in Korea. Since 1994, food scientists found that it contains higher levels of GABA (a major neurotransmitter with health benefits claimed in several pharmaceutical settings) than regular white rice. Interests in GBR indicate heightened adversity toward processed foods (such as white rice), growing concerns over chronic diseases caused by industrialized foods and advancement in bio-techno-science, all of which occur in Korea in its phase of late industrialization. Affected by theoretical frameworks of actor-network theory and posthumanist analysis, I demonstrated that GBR indicates a socio-techno-scientific network where a specific thought style and mode of behavior are co-produced. Food scientists' experimental findings, mass media discourses of modern risks and Korean female consumers all promote values of functional foods, thus creating a chain reaction in mainstream society. Along this chain, food scientists' interests in neurotransmitters are connected to the media's accounts on GBR's health benefits and mothers' interests in managing their families' health to on-line communities. By suggesting new analytical frameworks for natural and healthy foods after the 1990s, I expand the concept of risks from the general fear of industrialization into the interactive transformation of human, material and conceptual actors.

CHAPTER 1
INTRODUCTION

1. Functional Foods and Their Bioactive Components

During the late 1990s, a new health-administrative category, “lifestyle-related disease,” and a new food-marketing category, “functional food,” emerged together. Hasler’s (1998) scientific review article, “Functional Foods: Their Role in Disease Prevention and Health Promotion” provided an exemplary list of natural functional foods (including oats, soy, flaxseeds, tomatoes, garlic, broccoli, citrus fruits, etc.) and diseases that can be prevented by the regular intake of bioactive molecular components in such foods. For example, as beta-glucan in oat can reduce the level of total cholesterol and low-density lipoprotein, oats are considered to provide health benefits beyond basic nutrition (see Table 1 for a list of functional foods and their claimed health benefits). Accordingly, oats or food products containing oats are included in the category of “functional” foods. This dissertation analyzes the emergence of functional foods as a new mode to biomedicalize everyday practices. In so doing, this dissertation triangulates the previous sociological discussion over food industrialization, perceived health risks in reflexive modernity, and the understanding of human bodies through molecular terms (DuPuis, 2000; Goodman & DuPuis, 2002; Hess, 2004; Rose, 2003; Sibbel, 2007). At the same time, it seeks to address their limitation in discussing a new assemblage of natural foods, high-tech biomedicine and consumers’ everyday behaviors.

First, let me define the terms. In this dissertation, although I note existing confusions, I use the term “functional foods” to indicate foods *similar in appearance to, or may be, conventional foods, which are consumed as part of a usual diet, and are demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions*. This is one of the earliest guidelines for functional foods suggested in a policy report written by a governmental department (Health Canada, 1998). Lifestyle-related diseases include coronary heart disorders, diabetes, hypertension, mental disorders, some types of cancer and obesity. While “lifestyle-related disease” is often used interchangeably with chronic and non-communicable diseases, the term is based upon the idea that most of those diseases can be prevented by healthy diet and exercise. Along with the sedentary lifestyles of people, processed foods manufactured by the food industry are often blamed for the world-wide increase in lifestyle-related diseases. See, for example, the following excerpts from a website summarizing a report, “Preventing Chronic Diseases—A Vital Investment” (2005), written by the World Health Organization (WHO).

> Childhood obesity, according to the WHO, is associated with a higher chance of premature death and disability in adulthood. Approximately 22 million children under the age of five are obese. [.......] According to Dr Catherine le Gales-Camus, WHO Assistant Director-General of Non-Communicable Diseases and Mental Health, childhood obesity is emerging as the number-one public health problem. This problem, she said, has to be discussed with the food industry. Dr Robert Beaglehole, WHO Director of Chronic Diseases and Health Promotion, stressed that the food industry has a critical role to play since what people consume - in the form of processed foods - is what is available for them. He added that the WHO is currently in dialogue with the food industry (Third World Network, 2005).[1]

The notion of chronic diseases’ being caused by highly processed foods—such as canned or packaged foods produced by the modern food industry—is stated frequently by health-related institutes as the main reason to develop more functional foods with sound scientific evidences. The importance of developing functional foods is even more emphasized after the 1990s as chronic diseases are pointed out as the main factor of premature death and disability.

In 2003, the WHO and the Food and Agriculture Organization (FAO) issued an expert report on the relationship between energy-rich processed foods and chronic diseases, such as cardiovascular diseases, cancers, diabetes, and obesity. According to the press release available on the WHO website, the two UN agencies proclaimed the following (WHO, 2003).

> 1. Chronic diseases account for a significant part of deaths and diseases in the world (“The burden of chronic diseases—which include cardiovascular diseases, cancers, diabetes and obesity—is rapidly increasing worldwide. In 2001, chronic diseases contributed approximately 59% of the 56.5 million total reported deaths in the world and 46% of the global burden of disease.”).
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> 2. The main cause of chronic diseases is energy-rich and processed foods in urban diets (“Evidence suggests that excessive consumption of energy-rich foods can encourage weight gain, the report says and calls for a limit in the consumption of saturated and trans fats, sugars and salt in the diet, noting they are often found in snacks, processed foods and drinks.).

[1] The report is available on the WHO website (http://www.who.int/chp/chronic_disease_report/full_report.pdf).

> 3. Chronic diseases are no longer the concern of developed countries alone as more people in developing countries also experience industrialization and urban lifestyles ("More and more people in the developing world are suffering from chronic disease, a seismic shift from a few decades ago when chronic disease was associated with the rich, developed world. Increased urbanization—as rural people abandon their land and move towards the cities—plays a large part in this change, according to the report. City-dwellers are more likely to consume energy-dense diets—high in saturated fat and in refined carbohydrates. This sudden change in diet, combined with a sedentary lifestyle, is having a drastic effect on the urban poor.").
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> 4. WHO and FAO expect the member nations of the UN to adopt health strategies focused on the regulation of diets and lifestyles to reduce chronic disease occurrences in the world ("WHO and FAO hope the report's findings will provide member states with solid evidence to prepare national health strategies. The Expert Report urges national governments to aim for dietary guidelines that are simple, realistic and food-based. Finland and Japan, countries that have actively intervened in the diet and nutritional behaviour of their populations, have witnessed dramatic decreases in risk factors and plunging rates of chronic disease, the Report says.").

The tendency for WHO and FAO to recognize chronic diseases, industrialization, urbanization, and energy-dense diets as interrelated problems revealed that food risks perceived in late modernity covers a broader realm than food *contaminants* such as *E.coli* O157:H7 in spinach. Food risks in late modernity entail the construction of a "safe" type of foods as well as the avoidance of specific foods. From the association of foods and technoscientific perception of health risks, a new way to frame everyday lifestyles emerges. Most functional foods are marketed as daily consumable goods through which consumers can lower their risks of developing chronic diseases, as shown in the Table 1. Consumers are encouraged to be aware of scientific knowledge about antioxidants, for instance, in blueberries and to change their everyday habits according to their knowledge about foods. Meanwhile, bioscientific knowledge focusing on specific health claims and clinical trials with foods is produced to intervene in the most wide-spread realm in society—everyday lifestyles.

From the example of functional foods, we witness a widespread trend to employ a particular type of bioscientific research on foods in solving health risk problems caused by food industrialization and processing. In this trend, both problems and solutions occur in the same domain of everyday *lifestyle*. It is improper lifestyles that cause most of premature deaths and disabilities in today's society. Simultaneously, functional foods that are "similar in appearance to conventional foods and are intended to be consumed as part of a normal diet" are expected to reduce the health risks with their bioactive components (He, 2004).[2] The concept of foods enhanced with bioactive components inevitably blurs the boundary between foods and medicine. Moreover, consumers are increasingly redefining their expectation of foods—from basic nutrition and tastes to specific health benefits. Consumers of functional foods also reconstruct their everyday life as a place for health management. In other words, health management domain is extended from biomedical research institutes into everyday habits. Interest in functional foods since the late 1990s has been transforming everyday lifestyles into an arena where new scientific knowledge, techniques, health institutes, and disappointments in modern food-industrialization intervene together in pursuit of lifestyle-enhancement.

This dissertation begins with an attempt to analyze not just how the functional foods market develops, but also how scientific and social domains participate in transforming everyday lifestyles whilst promoting new interest in natural foods and their health benefits. Since the late 1990s, the tendency to seek health benefits beyond basic nutrition from foods has created a separate sector in food-biotech industry. The global and European functional foods markets are estimated at up to 33 billion and 2 billion US$ respectively. In the United States, functional foods with specific health claims achieved 0.5 billion US$ market share in 2000. In the same year, the total number of approvals in Japan under the Food for Specified Health Uses (FOSHU) label reached 174 with an estimated market value of about 2 billion US$. Food companies offering functional foods products (for example, Unilever, which develops cholesterol-lowering margarine enriched with soybean and rice bran oil) came to have their in-house R&D facilities specializing not just in basic nutritional science or food processing but in clinical studies as well (Menrad, 2003). Some natural foods or foods fortified with substances extracted from those natural foods have shown marked increase in sales after they were marketed as functional foods with the approved specific health claims.[3] The mass media frequently feature scientific findings

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[2] He's (2004) remark on functional foods was made in an opening address at *Regional Expert Consultation of the Asia-Pacific Network for Food And Nutrition* organized by the FAO Regional Office for Asia and the Pacific. He is an assistant director-general and regional representative for the FAO Regional Office for Asia and the Pacific.

on certain foods and their proclaimed health benefits. In brief, the social realms affected by foods with specific health benefits are expanding while calling for further analysis of this area.

This dissertation will analyze a specific functional foods marketed for regular consumption—Germinated Brown Rice (GBR), which has been generating roughly more than annual $200 million market in Korea and in East Asia since 2004.[4] Through a bioactive molecule called GABA (gamma amino-butyric acid) in GBR, this particular rice is connected to scientists' research, functional foods marketing, and consumers' health concerns. White rice has been the traditional symbol of richness in Korea. How could that be changed? How did some people come to regard germinated brown rice as more natural and functional than white rice and changed their marketing strategy or everyday food choice? What practices and narratives were involved to make that change? Before I attempt to answer these research questions, I will first explain the importance of analyzing functional foods as a separate category differentiated from other foods generally regarded as healthy.

2. Previous Studies on "Healthy" Foods

(1) Previous studies on functional foods. Sociological literature has not yet sufficiently analyzed processes **t**hrough foods with specific health benefits become prevalent. This does not mean that sociological literature has not analyzed foods that are generally regarded as healthy. Nonetheless, I regard that previous studies on "healthy" foods have not paid sufficient attention

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[3] Hasler (2000, p. 504S) gave examples of increases in sales through specific health claims. "For example, oatmeal sales began to increase in 1997 following the approval of the health claim. Since 1995, oatmeal sales increased approximately 19% and were up 9% for most of 1999. This is in stark contrast to the anemic figures for wholesale food prices in 1999, which for the 11 month period between January 1 and December 1 remained at 0.6%. Soy seems to be showing similar success in the marketplace, which has clearly influenced the number of new product introductions. New 1999 food products with soy featured on the package or ingredient level doubled from 170 in 1998 to well over 300 in 1999. Sales of soy-based products have grown 20% per year since 1995, and sales of soy-based meat alternatives have grown more than 45% each year since 1997, according to a study by Soyatech and SJH & Co."

[4] In a report written at the Korean Rural Economy Institute (KREI) for the Ministry of Agriculture and Forestry (MAF), Cho, Park, Byeon, and Choi (2005, p. 10) estimated that "in 2004, germinated hulled rice market is $30-50 million market." The market size is much larger if we consider that the reported only included 41 companies that produce germinated brown rice exclusively and did not include other companies producing GBR-related products. I make accounts on GBR-related products and their market size in Chapter 4.

According to a FAO conference paper, "GBR products are being sold as much as 15,000 MT in Japan, and the marketed value as much as approximately 15 billion yen (about $130 million)" (Ito, 2004, p. 3).

to social and technical practices in interactive dynamics through which certain foods become regarded as healthy. Before I present detailed reviews of previous sociological literatures on "healthy" foods, I will first introduce how food scientists and medical professionals have analyzed the social contexts in which foods with scientifically claimed health benefits are developed.

Food scientists have been active in indicating social changes related to the emergence of functional foods. For example, Hasler (2000) notes: "Consumers began to view food from a radically different vantage point in the 1990s. This 'changing face' of food has evolved into an exciting area of the food and nutrition sciences known as functional foods. (……) Interest in functional foods skyrocketed in the last decade due to a number of key factors, including the growing self-care movement, changes in food regulations and overwhelming scientific evidence highlighting the critical link between diet and health. The interest in functional foods has resulted in a number of new foods in the marketplace designed to address specific health concerns, particularly as regards chronic diseases of aging." Milner (2000) also mentioned that "increased health care cost, recent legislation [the Nutrition Labeling and Education Act (1990) in the US which established circumstances under which claims about specific disease prevention could be made about nutrients in foods], and scientific discoveries" as three reasons for the success of functional foods. Such analyses, though informative, tend to list social contexts surrounding functional foods' success without further problematization. [5] While they acknowledge the importance of social contexts as well as scientific findings in promoting functional foods, the so-called key social factors—self care movement and changes in food regulations—were simply stated without further analysis. Likewise, "overwhelming scientific evidence" that stresses the connection between diet and specific health benefits for chronic diseases is stated as an established condition without any attention to its actual processes of construction (Hasler, 2000). In this sense, some scientists' accounts on the emergence of functional foods as a "changing face of food designed to address specific health concerns" provide questions, rather than explanations, for sociologists (Hasler, 2000). How have some foods become situated in the intersection of biomedical research and everyday diet?

[5] How diverse national contexts formulate variations in consumers' acceptance of functional foods has also been analyzed mostly from the perspectives of food scientists and medical professionals. See, for example, Arai (2007) and Lajolo (2007).

The processes through which functional foods become situated in the junction between scientific evidence and rising concerns over chronic diseases can be understood as a kind of "biomedicalization." Clarke, Shim, Mamo, Fosket, and Fishman (2003, p. 161) defined "biomedicalization" as "the increasing complex, multisided, multidirectional processes of medicalization that today are being both extended and reconstituted through the emergent social forms and practices of a highly and increasingly technoscientific biomedicine." The term was previously developed to investigate the expansion of medical jurisdiction over various phenomena such as post-traumatic stress disorder (PTSD), premenstrual syndrome (PMS), attention deficit and hyperactivity disorder (ADHD), and so on. By attending to multisided processes through both social and technoscientific means, Clarke et al. argued that the expansion of medical jurisdiction is a result of active knowledge-making processes rather than "disease mongering" founded on misconception and ignorance. Along with Clarke et al.'s notion, I regard that making of fatty fish into a functional food indeed involves complex and multisided processes such as research on docosahexanoic acid (DHA) and coronary heart disease, clinical trials, American Heart Association's new guidelines in 2000 (which recommended two servings of fatty fish per week for a healthy heart), and the FDA's qualified claim on DHA's possible roles in reducing heart disease rates. Then, what newly emergent social forms and technical practices mediate the extension of medicalization into the realm of foods? In addition, what further changes does the biomedicalization of foods entail?

So far sociologists have not paid much attention to the "biomedicalized" character of functional foods. Part of the reason is there were only a few sociological studies that analyzed functional foods (Holm, 2003; Hess, 2004; Sibbel, 2007). Sibbel (2007) and Holm (2003) characterized the emergence of functional foods as a tendency to focus on "a bioactive agent [consumed] in *isolation* from the other components" (Sibbel, 2007, p. 557, emphasis added) or "single constituents in foods for health [which] *contrast traditional wisdom* behind nutrition policies that emphasize the role of the diet as a whole for health" (Holm, 2003, p. 1187, emphasis added). Accordingly, their studies have focused on putting functional foods under an overall frame of "highly *industrialized food* production system [which is] remote from the consumer" (Sibbel, 2007, p. 560, emphasis added). In this sense, the two studies extended a political economy perspective, employed for the wide-ranging discussion of food industrialization in conflict with traditional food production, directly onto the analysis of functional foods (Goodman & DuPuis, 2002; Murdoch, Marsden, & Banks, 2000). The process of producing functional foods was only examined in terms of *isolating* a bioactive component from whole foods.

In contrast, by focusing on more specific kinds of functional foods, Hess (2004) revealed an important characteristics of functional foods—their character as a *natural* health product. While Hess also described the progress of functional foods research as growing attention to "specific nutrients rather than whole foods," he mentioned "documenting omega-3 fatty acids in *grass-fed, organic* meats" (p. 503, emphasis added) as an example of functional foods research. Along with Hess, I think focusing on organic or "natural" type of functional foods is important. The two following excerpts from a company website and a newspaper article reveal some functional foods' complicated character as both natural and technoscientific foods (see Figure 1).

> Our family farmers treat their hens to an all-vegetarian organic diet rich in flax seed. Each of our "Heart Healthy" Omega-3 Organic Eggs provides an impressive 225mg of Omega-3, and is a good source of Vitamin E (Organic Valley, n.d.).

> Eight in 10 natural and organic consumers regularly read ingredient labels for health and nutrition content and express interest in purchasing functional foods with additional health, nutrition and dietary benefits [……] according to MamboTrack research from Collingswood, N.J.-based Mambo Sprouts Marketing. Consumers said they're most interested in [……] functional foods with added calcium (44 percent), omega-3 (44 percent), antioxidants (43 percent), probiotics/prebiotics (38 percent), and vitamin D (30 percent) ("Mambo sprouts marketing survey reveals organic consumers seek functional foods," 2010).

Although grass-fed meats with enriched omega-3, omega-3 capsules, and genetically modified pigs with enriched omega-3 can all be called functional foods according to the loose working definitions used in the food industry, it is not surprising to find market research noting tendencies to differentiate minimally processed functional foods from "unnatural" ones. For example, a market research published by the Hartman Group (2009, p. 3) labeled yogurt with high antioxidant berries as "enhanced functional foods" and sparkling water enriched with dietary supplements separately as "scientifically functional foods." Along with the categorization, the report argued that "products that have inherent functionality yet are enhanced through minimal food processing to have an added health benefit" (such as yogurt with high antioxidant berries) have a better marketing opportunity than functional foods that "appear as if they emerged entirely from a laboratory" (such as beverages supplemented with glucosamine). The expected success of "(more) natural" over "(more) artificial" functional foods makes the framework of industrialization insufficient for the analysis of functional foods.

In this sense, Hess's focus on *organic* functional foods indicates not just his research interest but also the limitation of analyzing functional foods in general under the framework of food *industrialization* mediated by *isolating* bioactive components from traditional whole foods. During the construction of the so-called organic or natural functional foods (which practically becomes a different category from functional foods in general), desire for traditional whole foods is not simply lost in or separated from the technoscientific processes of finding/enriching bioactive components. Instead of lumping industrialized foods together, empirical discussion over the dialectic relationship between traditional food culture, industrialization, and high-tech biomedicine in relation to the emergence of a new food category is necessary.

Yet, Hess's analysis of organic functional foods in specific did not pay enough attention to the role of high-tech biomedicine because Hess's main focus was on the conflict between the organic food movement and the mainstream food industry. Hess listed organic functional foods, organic food marketed generally as natural or healthy foods, and government-controlled organic foods as three branches of "object conflicts" that the organic food movement undergoes. Because the three branches were regarded as organic foods incorporated by industrialization, the dynamics of new social forms and technoscientific practices in constructing omega-3 enriched beef consumed to treat heart diseases rather than healthy organic beef were not analyzed in specific.

Overall, the question how particular health benefits of functional foods, especially in terms of preventing chronic diseases in aging society through the actions of molecular bioactive components, have become important issues to consumers, regulators, and scientists has been asked neither by scientists nor sociologists so far. Scientists did not problematize the processes through which social contexts interact with functional-foods-related bioscientific research. Sociologists, on the other hand, tended to overlook specific health benefits in the analysis of functional foods as they lump functional foods into the category of industrialized (organic) foods.

In contrast to Hess's analysis, I argue that organic/natural functional foods can be clearly differentiated from organic food marketed generally as "healthy" or "natural" foods. From the start, the processes of making organic/natural functional foods are not just mediated by the food industry but by food scientists and regulatory scientists. In 1994, the Food and Nutrition Board of the US. National Academy of Sciences (NAS) defined functional foods as “any modified food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains” upon an implicit premise that some functional foods’ health benefits can be verified by sound science. On the other hand, the NAS National Research Council’s report in 1996 concluded that “the great majority of individual naturally occurring and synthetic chemicals [including pesticides] in the diets appear to be present at levels below which any significant adverse biologic effect is likely, and so low that they are unlikely to pose an appreciable cancer risk” (The National Academic Press, n.d.). The NAS shows clearly different attitudes toward premised health benefits of functional foods and those of organic foods grown without synthetic chemicals. The US Department of Agriculture (USDA), while it certifies organic products, makes no claims that organic foods are safer or more nutritious than conventionally produced foods. On the contrary, USDA supports Functional Food Research (FFR) unit for its research in health-promoting foods. The point is not that functional foods indeed are healthier than conventional foods while general organic foods are not, as some scientists would like to claim. I simply point out that enormous amount of regulatory, discursive and scientific work is being done by multiple actors to separate functional foods from foods generally understood as “healthy.” From a political economy perspective, both processes of marketing organic foods under the vague label of healthy/natural foods and those of documenting omega-3 in organic meat will eventually result in industrialized organic foods in the end. However, to analyze specific social forms and practices of a highly and increasingly technoscientific biomedicine involved in the processes expanding medical jurisdiction over everyday-consumable, whole, natural foods, I propose to separate functional foods from other kinds of foods generally regarded as “healthy.”

Below, I will review sociological analyses on other foodstuffs generally regarded as “healthy” by consumers. Analyses of social forms and technical practices to spread “healthy” foodstuffs will be categorized as (1) research on organic foods, (2) “safe” foods that are characterized by the absence of some artificial contents or processing steps, (3) vitamins for dietary therapy. By so doing, I demonstrate that functional foods marketed since the late 1990s are connected to new social forms and technical practices rather than previously analyzed contexts.

Briefly, previous sociological literature on organic foods has analyzed several new *social* forms to spread organic foods such as counter-cultural movement or consumer ethics. However, few studies have paid attention to new technical practices to connect consumers' health concerns with organic foods. "Safe" foods such as non-GM foods have been analyzed in regarding various social and technical practices to contrast "natural" foods against "artificial" foods. Yet, practices of making "safe" foods are essentially characterized by the absence of risky materials or processes, which are markedly different from active practices of observing/enriching omega-3-rich functional foods derived from fatty fish. Consequently, sociological analyses of "safe" foods did not include the role of highly technoscientific biomedicine; rather they focused on old technical practices to make "unsafe" foods and their social implications. Research on vitamins, while focusing on the intertwining dynamics between new social forms and new technoscientific practices, has revealed detailed processes through which vitamin treatments could be converted from alternative self-care into a kind of boundary object. Like functional foods, vitamins are a means for dietary management of diseases. Yet, there is insufficient analysis on how vitamins are connected to new tendencies of biomedicine—which focus more on constant care and management of diseases rather than acute interventions. Instead, previous studies have focused mainly on the premises and practices of the mainstream biomedical community to seeking to exclude dietary management and thus construct their own boundary between medicine and health activism. There has been little attention to multiple practices seeking to insert dietary management of diseases into the mainstream biomedical community, which I argue is necessary to sufficiently analyze the emergence of functional foods. Below, I will first review previous literatures on foods generally regarded as "healthy" in an attempt to reveal what has *not* been addressed so far in the discussion of healthy foods. Then, I will illustrate how functional foods development works as an important site to observe and analyze new processes of biomedicalization through foods.

(2) Organic foods. "Healthy for you, healthy for the environment" (Lawrence, Lyons, & Lockie, 1999) was the slogan of a certified organic cereal maker in New Zealand. This slogan probably captures the popular image of organic foods that are guaranteed to have been produced, stored, and processed without the addition of synthetic chemicals and/or fertilizers (Burch, Lyons, & Lawrence, 2001). Several quantitative studies have confirmed general consumers' tendencies to regard organic foods as healthy, natural, and environmentally friendly food. For example, national survey of 1,200 Australian consumers revealed that a significant number of respondents regarded organic foods as healthy and industrialized foods as the cause of environmental and health risks with Cronbach's alpha of .72 and .75, respectively (Lockie, 2002). According to Danish surveys, the reasons most frequently and consistently mentioned by consumers for choosing organic foods were also personal and family health (Gallup, 1999).

However, many social studies of organic foods have not analyzed health concerns as an important factor in constituting the food category. More attention has been paid to processes of producing, circulating, and consuming organic foods in relation to the reflection over the failing food industrialization. For example, Belasco (1989) described organic farming in the late 1960s and early 1970s as a counter-cultural attempt to move away from modernization and come back to natural, simpler and healthier life. In many social literatures, modern agricultural and food-processing techniques are understood to alienate food consumers from nature, local communities, and traditional knowledge (Belasco, 1989; Hecht, 1995; Vos 2000; Whatmore & Thorne, 1997). In relation to such critiques of modern foods, much emphasis on organic food was made in the philosophical and politico-economic dimension. Thus, many analyses on organic food had their focus on the role of organic food agriculture in engendering anti-modern frames such as respect to nature, back-to-the-land, ethics of care, and localism.

In terms of consumption, Guthman (2003) summarized organic food consumption as *reflexive* eating. According to Guthman (2003, p. 46), reflexive consumers pay special attention to how food is made as they are conscious about the "de-skilling, racializing and youthening" of food-processing work; their interest in a healthier body is only an implied consequence of their reflexive taste. The emphasis of sociologists such as Guthman on philosophical and ethical values of organic foods is echoed by organic food advocates as well. According to Vos (2000), in public comments made on the USDA National Organic Program website, organic food advocates pay little attention to general organic food consumers' interests in personal health. Rather, these advocates emphasize "hard-earned confidence built between organic producers and consumers," "creating balanced cycles, preserving resources, and respecting diversity," "humane treatment of livestock," and "a process-based standard rather than a product-based standard" for organic food and farming (Vos, 2000, p. 248-249).[6] Allen and Kovach (2000) also emphasized that the Organic Trade Association's (OTA) first reason to buy organic is not a claim about health benefits but a claim about production processes.

Historically, it is noted that organic food agriculture began with both moral and health-related concerns over synthetic fertilizers and industrial pollutants (Altieri, 1995). Still, as Belasco (1989) noted, organic food was supposed to provide not just physical health but rather "personal wholeness" in an "organic community of mutual responsibility" (p. 187). Health concern over industrialized food was a less important driving force for organic food movement. Public's interest in ecological sustainability was also more about hippie organic farmers' social consciousness rather than about technical concerns over soil productivity (Belasco, 1989). Thus, organic food movement has been employed as a site to analyze the political struggle of counter-modern, counter-global, and counter-capitalist actors to frame social risks of food industrialization, such as the global corporate regime that de-skill food-processing workers (McMichael, 2000). However, organic food movement so far has not worked as a site to analyze technoscientific practices to convert certain foods into foods with health claims.

(3) "Conventionalized" organic foods. As organic foods become incorporated into the mass market, motives for their purchase seem to move beyond economic localism. Surveys and focus group studies support the view that general consumers expect health and safety benefits as major quality characteristics of organic foods (Byrne, Toensmeyer, German, & Muller, 1991; Goldman & Clancy, 2009; Jolly, 1991; Thompson, 1998). Meanwhile, so-called "greenwashed" organic food products or shallower forms of organic agriculture became issues for sociological studies. The arguments that the organic food industry is being "conventionalized" by highly capitalized "factories in the field" have been echoed by many agro-food studies, although there are some debates on small organic producers' room for maneuver (Buck et al., 1997; Coombes & Campbell, 1998; Guthman, 2000; Hall & Mogyorody, 2001; Michelsen, 2001). Within the political economy-based framework, organic foods—incorporated into transnational agro-food corporations, marketed through the supermarket chains, certified by standardized production processes and not by the ideological contents of the organic movement, and so forth, were

[6] See also Buck, Getz, and Guthman (1997) for discussion of organic food consumers' interests in producer-consumer relations and environmental sustainability.

evaluated as evidence of agribusiness eroding the alternative form of food production/consumption (Goodman, Sorj, & Wilkinson, 1987; Whatmore, 2000).

Certainly, organic foods are mushrooming rapidly not least due to certain forms of industrialization and mass marketing. Organic food sales have increased at least by 20 percent annually since 1990. In particular, between 1992 and 1995, the number of registered organic farmers in the US increased by 55 percent and net sales of such certified organic products increased by more than 200 percent (Klonsky & Tourte, 1998). In 2000, more organic foods were purchased in conventional supermarkets than in natural food co-ops, retail stores, farmers markets, or other community organizations. Currently about 73 percent of all conventional grocery stores sell organic products (Dimitri & Greene, 2007).

The category of conventionalized, industrialized or standard-oriented organic foods for large-scale consumption has been characterized by several sociologists as less sustainable and less socially conscious food choice. From a politico-economic perspective, McMichael (2000) criticized the USDA's 1997 attempt to redefine organic food standards to allow the use of genetic modification, food irradiation, toxic sewage sludge in organic agriculture and even more liberal use of chemicals on crops. By his account, standardized organic foods are "corrupted greenwash," which does not work as counter-movement against the global food corporation. There is evident similarity between McMichael's arguments and the Organic Consumers Associations' critiques of the USDA organic standards.

While some sociological accounts of organic food movements promoted the movements' genuine moral tenets, other sociological analyses focused on the gaps between early organic food movements and "conventionalized" organic food market. Guthman's (2003) historical account on the transformation of counter-cuisine into "post-counter-cultural organic" (p. 47) since the late 1980s described how conventionalized organic foods, health concerns and young urbanites' body ideals have stabilized each other. With Californian upscale restaurants' successful marketing of organic menus and the popular media's increasing juxtaposition of unhealthy body fat with working-class diets (such as convenience food), organic salad mix gradually came to be included in the category of healthy and fashionable foods, rather than counter-cuisine. Her historical analysis revealed continuous processes of the bifurcation of counter-cuisine and so-called "yuppie" organic. Hess (2004) also noted that "embedding of the organic foods category in a broader category of *health or natural* foods" (p. 504, emphasis added) is evident in the post-counter-cultural organic food industry. According to Hess, because the category of "healthy" foods can only have a vague meaning, incorporating organic foods category into health foods category reduces organic foods to the status of merely one consumer option among many. Hess's and Guthman's perspectives are similar in a sense that healthization of organic foods is evaluated as the process of separating organic food consumption from environmental concerns.[7] Thus, it can be said that unlike organic food production-consumption as a counter-cultural movement, "conventionalized" organic foods worked as a site to analyze actual processes through which a certain foods become recognized as "healthy."

It is not my interest to examine whether conventionalized organic foods are indeed healthy or not. Again, the purpose of this section is to review several foods with *claimed* health benefits in order to illustrate the *particularities* of functional foods. I also did not separate post-counter-cultural organic foods and "original" organic foods because I believe they have actual differences in terms of their health benefits. The important differences between the two food types lie in their distinct ways how, and if, claimed health benefits attempt to produce a food category. As explained above, sustainable organic food eaters have been, in general, noted to obtain tastes for "counter-cuisine" as a result of their heightened social anxiety rather than of their interest in presumed health or safety benefits (Belasco, 1989). On the contrary, the emergence of industrialized organic foods was described by several social literatures to include processes of disseminating health concerns. Still, the processes of the mainstream food industry to conventionalize organic foods were mainly analyzed with an emphasis on global food corporations or marketing strategies to valorize yuppie organic foods. There was insufficient attention to bioscientific or medical practices in relation to the emergence of organic foods as "healthy" foodstuffs.

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[7] The understanding of "healthy" foods as diluents of the social meaning in purely alternative forms of organic foods has affected the discussion or functional foods. Sibbel (2007, p. 560) suggested delaying investment in the development of functional foods while arguing that functional foods "undermine the possibility of learning about food through experience." According to her, although some functional foods are natural whole foods, health claims are made based not on natural whole foods themselves but on bioactive components. Such focus on scientifically understood components in whole foods is criticized, as it is supposed to increase discrepancy between consumers' and producers' understanding of foods. In short, both "conventionalized organic" and "functional" foods have been lumped together and criticized as pseudo-alternative foods by previous sociological studies.

(4) "Safe" foods. Some foods can be characterized by the absence of "artificial" technoscientific ingredients such as transgenic genes, growth hormones, or chemical preservatives. Sociological studies of such foods tended to use an analytical framework different from the one employed in the studies of organic foods. In discussion of "safe" foods, the tension between traditional food production and industrialization is a less important topic because most "safe" foods are, ironically, industrialized foods from the beginning unlike traditional organic foods.

In her analysis of the rise of organic milk, DuPuis (2000) particularly emphasized that organic milk consumption is not accompanied by organic marketing channels such as food co-ops or farmer-consumer coalitions. Unlike some organic foods deeply rooted in the earlier counter-culture movement and "alternative" marketing channels, organic milk from the outset arose from large-scale capital without transitional "hippie food" period or the so-called "incubator environment" provided by politically conscious consumers. The annual sales of organic milk were estimated to reach approximately $60 million in 1998 (Scott, 1997). Moreover, Horizon Organic Diary accounts for 65 percent of the total organic milk sales in the US, and four other large-scale companies account for 30 percent.

There is no doubt that organic milk industry is closely connected to the capitalist food economy rather than the alternative social-natural assembly supported by traditional organic/local food movement. However, DuPuis went further than indicating the lack of social/political values in organic milk consumption. Her study revealed interesting processes through which organic milk is connected to consumers' particular health concerns. Risk claims concerning the controversial ingredients, rBGH (recombinant bovine growth hormone), are central in her analysis of organic milk. rBGH is a product of recombinant DNA technology, injection of which to dairy cows has made cheaper production of milk possible. While most conventional milk is produced with rBGH injection, controversial claims have been made about its possible health risks (such as higher probability of developing breast cancer).[8]

DuPuis described the controversy over rBGH and its health risks as the nexus through which business, government experts, scientists and consumers become connected to organic milk production/consumption. By so doing, DuPuis criticized previous studies on mass-market organic foods for focusing exclusively on the political economy of global food corporations or yuppie organic consumers' display of cultural capital (Buck et al., 1997). DuPuis did not regard

[8] For claims on health risks of rBGH, see Parodi (2005).

organic milk as simply another case of greenwash or a status symbol (Bourdieu, 1984). Rather, DuPuis argued that organic milk consumers participate in "reflexive consumption," where an individual consuming action is embedded in a network of risk politics similar to "NIMBY" (Not-in-My-Backyard) environmental movements. Multiple social forms and practices work to connect organic milk consumption with the question of how to deal with technoscientific food risks. Messages on a milk carton such as "You deserve delicious foods that are safe and healthy" create a friendly appeal to consumers. The ability of Horizon, a multinational food company, to create an organic milk brand is also an important factor to sustain the large-scale anti-rBGH network. Also, when the Horizon milk carton tells "After all, cows are mothers, too, and we watch our cows' diet for the same reason a mother watches her own," a certain ethical claims work to link consumers' health concerns to anti-rBGH as well as to animal welfare issues.

Reflexive consumption of organic milk can be understood as a case of a more general phenomenon in late industrial society. The general notion of "risk society," where people become increasingly conscious of the hazards produced by technologies has been developed by Beck (1992).[9] It needs to be noted that Beck did not argue the absolute level of risk has increased in post-industrial society. According to Beck, people's *perception* of risks increases in post-industrial society mainly for three reasons. First, risks caused by modern technoscience affect broad—almost global—ranges as seen in the Chernobyl accident. Second, extended sensory organs of technoscience work and visualize previously invisible risks such as minute amounts of chemicals or radioactivities. Third, people become more aware of the unintended consequences technoscience, whose progress can cause so-called "boomerang effects." Thus, it is not important in the discussion of risk politics over organic milk that specific health risks of rBGH have not yet been entirely confirmed. Risk politics occurs around social and technoscientific processes that are intertwined to increase risk perception of rBGH.

Consequently, DuPuis's study focused on multisided processes of making consumers *perceive* health risks of rBGH, a product of modern biotechnoscience. However, the actual

[9] Not surprisingly, Beck (1992) also mentioned agricultural chemicals and their potential health risks diffused through the food chain as a brief illustration of modern risks. However, Beck's main interest is not in food risk in particular but in risks' political potentials based on people's anxiety regarding modern progress. Consequently, Beck's short comments on fertilizers, pesticides, and herbicides were not connected to empirical analyses of how people's reaction against such "unsafe" food technologies is connected to specific social phenomena—such as the emergence of natural, organic, or non-GM food markets.

processes of making organic milk perceived as "safe" or "non-risky" foods were examined exclusively in the social realm—such as in advertisements and retailing. Technical practices mentioned in this study were limited to the injection of rBGH. In this sense, DuPuis's study was about social struggles related to scientific claims made about a "risky" technoscientific practice—which is to produce and inject large quantities of growth hormones into cows. The study did not analyze the extent to which biotechnoscientific practices and late modern social forms could interact together and construct certain foods as "safe," healthy, or recommendable for everyday consumption to reduce the risks of specific diseases.

Several other studies have analyzed anti-GM or "safe" food consumption while paying much attention to cultural contexts in which consumers are situated. Lupton (2005) indicated that Australian consumers concerned about health risks of GM foods employed acculturated belief systems in the absence of clear knowledge, which often entailed the use of dichotomous discourses—such as natural/artificial, clean/dirty, wholesome/junk and pure/contaminated foods. Tulloch and Lupton (2002) focused on highly educated and affluent interviewees who were ready to assess risk claims related to GM foods and enjoyed their identities as "consumers of science." Here, consumers' attitudes to technoscientific risks were considered as the products of acculturation in particular social contexts—such as the working environment of high-tech or science industries in Oxfordshire villages—rather than as general fear determined by post-industrial condition.[10] Interviewees emphasized the importance of ensuring a "balance" in food consumption—such as eating a little GM food but not feasting on American soya—over taking an extreme position—such as not eating GM foods at all—with insufficient amount of information. Similar to Tulloch and Lupton (2002), Wilk (2006) noted that the general public's attitude is more complicated than general fear of modern technology. Wilk examined marketing of bottled water with the labels of "pure," "pristine," or "natural." While bottled-water market reaches annual sales of 89 billion liters worth $22 billion, the industry contrasts the "purity" of their products with the uncontrollable danger from public supplies of tap water. Yet, more than 65 percent of bottled-water consumers in the US remained skeptical about the healthiness or safety of bottled water. Wilk argued that while consumers do not have fear of tap water in general, consumers also tend not to trust state agencies which have shown the propensity of

[10] Still, Tulloch and Lupton's research is not incompatible with Beck's because their interviewees also share certain features of anxieties in risk society—most interviewees agree that health risks caused by GM foods are incalculable and could be catastrophic.

establishing less rigorous standards of "unsafe" foodstuffs than private companies—for example, in the US., McDonalds refuses to buy GM potatoes while the government allowed unlabeled GM foods into the food chain (Jasanoff, 1997). In such particular circumstances, people are willing to trust the label of purity provided by private companies relatively more than the one provided by state agencies. Lupton and Chapman's (1995) focus group interview also revealed the lay public's complicated reactions toward low cholesterol diets. While respondents expressed moralistic discourses that they need to "work" to reduce the risk of coronary heart disease and stay healthy, they also exhibited a high degree of cynicism toward the media's coverage and scientists' health-promotion orthodoxies.[11]

The above studies on "safe" foods in risk society, by attending to consumers' cultural contexts in constructing a distinct food category, are differentiated from most political economic studies on organic food production. Even though most "safe" foods are also the products of food industry rather than of local producer-consumer coalitions, the conflict between agricultural communities and industrialization was not analyzed as the core problem.[12] Rather, the studies examined the interplay between the "safe" food industry's marketing strategies and consumers' ways of assessing risks in their everyday food choices. Indeed, the "safe" food industry's appeal to consumers' desire to avoid technoscientific risks can be found frequently in advertisements. rBGH-free organic milk carton in the picture below combines the label of "No artificial growth hormone" with the image of clean living cows. As a whole, "safe" and healthy foods have worked mainly as a site to analyze the cultural processes of reflexive consumption through which unintended side effects of technoscientific practices are led to the production of "unsafe" foods. On the other hand, "safe" foods have not worked as a site to analyze performance of technoscientific materials/practices that *connect* some foods to certain safety or health claims. Unlike functional foods (such as omega-3-enriched organic beef), "safe" foods are defined by the

[11] Lupton (1993) noted such increasing focus on and anxiety about health risk through the work of the mass media and medical, scientific, and legal institutions as the main characteristic of late modernity.
[12] Goodman (2001) termed the tendencies to analyze food-producing technologies as the vectors of capitalist penetration into agricultural nature as "first generation" analyses of agricultural biotechnologies. For example, Kloppenburg's (1988) discussion over plant genetics regarded technologies as processes of reconfiguring nature into capitalist property. Goodman criticized such framework's tendencies to overly privilege human agencies in embodying the socio-political ramifications of a technology. To address the materiality of nature-society interactions in food production, Goodman proposed to use concepts and perspectives of the actor-network theory (ANT), which I used in this dissertation as well. DuPuis's (2000) study is a case of ANT-affected analysis, where organic milk consumption is understood as a network built by associations of humans and nonhumans (such as rBGH).

absence of certain risky materials. Perhaps because of that intrinsic property, wider implications of technoscientific practices, beyond eliciting food scares among consumers, could not be analyzed in the study of "safe" foods.

(5) Dietary therapy. In the 1970s, vitamins came to receive much attention as an alternative cancer therapy. Food-based substances, instead of herbs as a form of whole foods, emerged as an important player in health movements for alternative medicine in the US since that decade. Vitamin-related organizations such as Committee for Freedom of Choice in Medicine were active in advocating the use of vitamins for cancer patients. In addition, the US food industry came to develop dietary supplements containing highly enriched vitamins (such as bovine and shark cartilage) in an attempt to target cancer patients. According to an article in *Forbes* in 1979, the US sales of vitamins have been more than $1.2 billion with a growth rate of 10 percent since 1970 (Senecker, 1979). Undoubtedly, the health food industry has been active in expanding the vitamin market and recruiting "believers" in alternative cancer therapy (Richards, 1988; Hess, 2005).

Yet the 1970s and 1980s were also the periods, when the mainstream medical community actively sought to exclude vitamin C from legitimate cancer therapy. Richards (1988) analyzed the processes through which therapeutic efficacy of vitamin C was evaluated by the mainstream medical community. She examined the well-known controversy over the vitamin C treatment between Linus Pauling and Charles Moertel at Mayo Clinic. In two clinical trials at Mayo Clinic performed in 1979 and 1985, the results of vitamin C treatment for cancer patients were negative. Pauling's ideas of "orthomolecule"—the right molecule for a disease—were denounced by medical professionals as unscientific. Yet Richards note that Pauling's claims about vitamin C have not been tested with the same methods employed in his clinical research in the Vale of Leven Hospital. For example, administration of vitamin C was stopped immediately when tumor progression became evident in the Mayo clinical trial, while in Pauling's trial, vitamin C medication continued until death to alleviate symptoms rather than kill cancer cells. Richards argued that the methodology used by the Mayo team in clinical trials of vitamin C reflects their deep commitment to the frames and values of the mainstream medical community. Because mainstream cancer researchers at that time could not incorporate the idea of host non-toxic treatments, they tested vitamin C as they would test any routinely-used cytotoxic drugs, which are supposed to be administered for brief periods of time. It seemed mainstream cancer researchers “made no attempt to evaluate the efficacy of vitamin C” (Richards, 1988, p. 672) within the perspectives of vitamin C researchers because of the “ideological differences” between them (Richards, 1988, p. 655). Though Pauling’s research on vitamin began as an extension of his earlier work in mainstream molecular biology, the Mayo clinical trial pushed the research into the “alternative camp” of health social movement and alternative medical practitioners. In sum, Richards’s analysis revealed cancer clinical trials as technical processes through which the mainstream medical community marginalized and excluded nutritional therapy from the realm of “science”—even though holistic health movement and health food industry kept booming around the vitamin C market during the 1980s.

After the 1990s, nutritional/dietary therapies underwent considerable transformation. Hess (2005) noted that medical practices in clinical settings came to incorporate, rather than marginalize, many elements of nutritional and dietary therapies. Before the 1990s, dietary/herbal therapy was a marginalized form of medical knowledge-practice. Surgeons, drug-prescribing physicians and pharmaceutical companies with their patented drugs were highly resistant to dietary approaches to diseases. In such circumstances, vitamin-related research gained most supports from social movements for alternative therapies (Schneirov & Geczik, 1996). Yet, after the 1990s, the food industry and the National Center for Complementary and Alternative Medicine played a major role in supporting studies on vitamin and cancer prevention. Hess argued that such changes resulted in the transformation of alternative cancer therapies in general. Previously supported by patient organizations and health social movement activists, alternative cancer therapies involved broader concerns than advocating vitamins or herbal treatments—mainly, supporters of alternative therapies pursued fundamental changes in the assumptions of modern scientific medicine connected to materialistic philosophy and financial interests. Accordingly, Hess described the emergence of vitamin as transformation of alternative cancer therapies affected by the mainstream biomedical community and the food industry. From Hess’s perspective, vitamin could be incorporated in the medical realm by becoming “complementary” to conventional therapies rather than “alternative.” Hess emphasized that the adjuvant use of vitamins for cancer therapies in the post-1990s was different from Pauling’s original design, where megadose treatment of vitamin was not accompanied with chemotherapy.

Richards's study employed vitamins to analyze scientific contestations over the efficacy of a medical treatment in relation to power dynamics between the mainstream and alternative medical communities. Similarly, Hess's discussion of vitamins analyzed the incorporation of health social movement by the mainstream biomedical communities; the focus was on the transformation that an alternative technology underwent during the process of integration. Both studies examined technoscientific practices—be it in a form of clinical trial or of dietary supplement production—which made vitamins take off as "alternative" or "complementary" cancer therapies. In particular, much attention was given to the contexts in which the mainstream biomedicine either excluded or only partially incorporated vitamins as an alternative method of cancer treatment. In a sense, Richards's and Hess's studies revealed counter-processes against the attempted biomedicalization of vitamin.

Yet, it is interesting to note that both studies mentioned the emergence of "preventative medicine" as an important event in the mainstream biomedical community since the 1980s. For example, the report "Diet, Nutrition and Cancer" was published in 1982 by the National Research Council (NRC) commissioned by the NCI. In 1984, the National Cancer Institute introduced a "Cancer Prevention Awareness Program" focusing on tobacco use and diet. It seems natural to see some connection between this growing interest in disease prevention through everyday habits and consumption of healthy dietary supplements such as vitamins. However, the two above-mentioned studies have not analyzed the processes through which interest in preventative medicine produce vitamins as healthy foodstuffs. Instead, Richards focused on the mainstream medical professionals' (such as oncologists') attempts to denigrate scientific evidence of dietary treatment while claiming their own expertise in cyto-toxic methods of cancer treatment. Hess, while stating that some of the funding for the studies on cancer prevention came from the functional foods and dietary supplement industry, did not empirically examine the processes through which functional foods research/production facilities embedded vitamins into new social/scientific culture of preventative medicine. Again, Hess's main interest was in the transformation of alternative cancer therapy as social movement, rather than the constitution of preventative medicine as a result of social and technical practices. In sum, while previous studies have analyzed vitamins as an "alternative" technological product, their discussion was limited in regard to how regularly used foodstuffs are biomedicalized with a new emphasis on preventative medicine.

So far, I have reviewed previous literatures on foods generally regarded as "healthy." In doing so, I have revealed that previous studies on "healthy" foods have not paid sufficient attention to social and technical practices through which certain foods become regarded as healthy. In the following two sections, I will introduce two analytical frameworks that I will employ to examine social and technical practices to produce functional foods. I will also explain in what sense functional foods need to be discussed in the context of reflexive modernity, biological citizenship and STS-inspired thinking rather than under the general framework of food industrialization or conventionalization of natural foods.

3. A New Framework to Analyze Functional Foods

(1) Risk and reflexive modernity. Let me briefly restate the late-modern interest in preventing lifestyle-related diseases through healthy diets. In a broad range of regions including the US, Europe, Canada, Japan, and in Korea, the growth in functional foods sales goes hand in hand with ever-increasing scientific evidence to support specific health benefits exerted by bioactive components in functional foods. Not just sales in functional foods but sales in all of "alternative" foods, which claim to be more natural or healthier than conventional industrialized foods, have increased since the 1990s.[13] Since then, people's everyday habits of eating processed foods produced by modernized food industry have been increasingly perceived as the source of health risks. Such suspicion regarding modernized food industry overlaps with a more general tendency in modern society to perceive risks from a modern technical system of production.

"Risk" is a singular phenomenon in late modernity and is differentiated from threats in pre-modern societies (Beck, 1992). People have been aware of and lived with threats of natural disaster, unexpected financial difficulties, diseases and illnesses throughout the human history. Yet, what is special about risk in late modernity lies in (1) its (potentially) global scope and (2) temporally specific situatedness *after* systematic industrialization. It needs to be noted that both of the above factors are strongly associated with the advancement in technoscience. Risk society,

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[13] For the statistics and discussion on the sales of natural, healthy, or functional foods, see the paper series published in the *British Journal of Nutrition* in 2007 (Arai, 2007; Lajolo, 2007; Milner, 2007; Verschuren, 2007). The series of papers presented in the symposium on functional foods provide a global overview on the health concerns and foods with medicinal properties in Asia, Europe, Latin America, and North America.

as Beck noted, indicates a mixture of techno-economic development in advanced modern societies and its side products regarded as “hazards and potential threats [that] have been unleashed to an extent previously unknown” (p. 19). Risk in late modernity can be translated as techno-economic risk unfolding into an unprecedented magnitude.

With its high productivity for markets as well as its potential threats mediated by technology, today’s food industry most vividly exemplifies conditions of techno-economic risk. High-yield crops, increased productivity in farm factories, and long shelf-life of foods in the supermarkets are available for urban diets. Yet, simultaneously, fear and concerns over chemical additives, pesticides, meat-bone meal fed to cattle, and food poisoning in mass-produced packaged foods have become more widespread than any time before. The possible extent of harm is indeed global and such a previously unknown scope of risk is only the opposite side of the enormous productivity, availability, and conventionality provided to urban food consumers by modern technoscience.

A well-known nickname for genetically modified crops, “frankenfoods,” reveals an increasing social tendency to understand various food risks as the outcome of technoscientific development. As Latour (2003) noted, distrust in modernism as “a coherent set of values and objects” is prevalent in late modernity (p. 42). Trust in food processing technonology as a means to increase the shelf-life of butter is undermined by growing health concerns over trans-fats in shortening. Trust in technology-laden agriculture as a mean to increase food production yield is weakened by concerns over the excessive use of chemicals. Surely, fading trust in agro-food technology does not conflict with the observations that multinational corporate world with technoscientific means of production continues to hold enormous power over the global food market (McMichael, 2000). Yet, it also needs to be mentioned that distrust in modernism has become a common theme in foods. The argument that technoscientific development should be supported to ensure high productivity cannot be made without eliciting some kinds of controversies seen, for instance, in anti-GMO movements (Buttel, 2003). The power of the global food market often faces significant resistance employing alternative discourses of environmental stewardship, politico-economic independence of food growers in the global south, cultural diversity, precautionary principles in daily consumed objects, and/or sustainable growth in agriculture. The problem, then, is no longer that alternative discourses for counter-movements *against* scientific modernism do not exist in the social debates over foods. We already have so many discourses to support the argument that modern technoscientific system of food production, distribution, and consumption has met its boomerang effect. The problem lies in the absence of a framework to simultaneously analyze still-remaining modern ideals of technoscientific development, what Beck called as reflexive modernity (or as Latour put as, "disappointed" modernism [Latour, 2003, p. 42]), and unexpected consequences generated from their intermingling.

As Beck (1992) noted, the side products of technoscientific-industrialization, such as health risks of processed foods, work reflexively *against* modernity.[14] Yet. a brief look at functional foods reveal that the perceived health risks can also *strengthen* ties which began with modernity between technoscience, the lay public, and foods. In this dissertation, I suggest a fresh framework to see risks not as a mean to avoid technoscience, but as a surface on which new forms of alliances and resistance emerge. What is produced out of perceived food risks cannot be analyzed as a general avoidance of modern industrialization. A brief example can be borrowed from a WHO report (2003) stating that "daily intake of fresh fruit and vegetables (including berries, green leafy and cruciferous vegetables and legumes), in an adequate quantity (400-500 g per day), is recommended to reduce the risk of coronary heart disease, stroke and high blood pressure" (p. 89). In dealing with the perceived risks of chronic diseases, the report reveals more than the boomerang effects of convenience foods or consumers' heightened sensitivity to health issues. In the report, we see a citation of a research article "Fruit and Vegetable Intake and Risk of Cardiovascular Disease: The Women's Health Study" published in *American Journal of Clinical Nutrition* (Liu et al., 2000). The report urged health officials to "work with advertising, media and entertainment partners…… to stress the importance of clear and unambiguous messages to children and youths" (WHO, 2003, p. 7) that they need fruits and vegetables. Here, the turn to berries and cruciferous vegetables is achieved by the *collective* action of scientific experts, fruit in scientific laboratories, organized force, and discourses. A turn to nature in this sense is not simply about going "back" to nature remaining as unadulterated residues of industrialization. Rather, nature is actively constructed as a place where both social and technoscientific actors intervene to manage risks of modern/urbanized diets.

Through the development of functional foods, I see that several conventional themes in modern society are reconstructed. First, the boundary between "natural" foods and foods

[14] See also Beck, Bones, and Lau (2003) for the discussion on "reflexive" modernization.

produced by technoscientific means becomes blurred. The previous literature on conventionalized organic foods has already noted that some foods that claim to be "natural" contain "unnatural" elements such as the supermarket chains for circulation or Chilean nitrate allowed by the USDA's organic standards. However, examinations of "organic-lite" also contain explicit or implicit arguments that some organic foods can qualify as "a purely alternative form of organic" if they are based on a "holistic vision of organic" rather than standardized production processes, or if they are produced by "the lifestyle-oriented" rather than "commercially-driven players" (Guthman, 2004, p. 304). Functional foods, on the other hand, reveal a new site where the understanding of "natural" foods cannot exist separately from high-tech biomedicine. Second, the boundary between scientific experts and educated amateurs such as journalists comes to be blurred in their performance to circulate scientific information. This is not to argue that the experts' group *per se* does not exist. Scientists in the FDA in general have more expertise than health activists or journalists. Yet, the public can see different scientists providing different answers to the same question, for example, whether green tea reduces risk of certain types of cancer. While Hasler (2002) stated that there is only weak to moderate epidemiological evidence to support the specified health claims of green tea, McKay and Blumberg (2002) introduced multiple clinical trials arguing for the inverse relationship between green tea and cancer occurrence.[15] Just as different journalists have different opinion, scientists' community cannot work as the objective arbiter to provide the definite answer to health-concerned consumers. Understanding scientists' communities through Mertonian norms—objective and disinterested—become unsustainable to many (Merton, 1973). On the other hand, influence of the educated amateurs, such as activists or journalists, on health-related information is increasing. Finally, the boundary between the medical realm and everyday lifestyles become unclear. The everyday of food consumers becomes a site to which social actions (such as the mass media stressing the importance of taking fruits regularly) and biomedical research (such as clinical trials on green tea consumption) are related. In sum, functional foods reconstruct boundaries in multiple sites while emerging as a means to reduce health risks in reflexive modernity.

[15] One of many clinical trials reviewed by McKay and Blumberg (2002) introduced a Japanese clinical trial of 472 stage I and II breast cancer patients, which showed an inverse correlation between the consumption of green tea and the rate of recurrence after seven years.

(2) Biological citizenship in late modernity. The reconstruction of multiple boundaries between nature/technoscientific, experts/amateurs, and biomedical/everyday with the emergence of new biomedical commodity has been analyzed previously by Rose (2003). While exploring how neuropharmacology brought "a fundamental shift [that] had occurred in psychiatric thought and practices" by the 1990s, Rose argued that the development of "smart" psychiatric drugs (which targets specific neurochemical structures of the brain to control mental disorders) entailed a broad range of social transformations (Rose, 2003). First, the understanding of mental health and anomalies are now mediated almost always by knowledge and theories of neurochemistry—where mental activities are understood in terms of chemical reactions in the nervous system. Second, the new ways of understanding psychiatric conditions are connected to the emergence of the big neuropharmaceutical industries and markets in the developed world. Third, such understanding is relayed to the lay public not much through the government-centered institutions but more often through the marketing language emphasizing the individual happiness, which one can now choose to *consume*. Lastly, as consumers in neuropharmaceutcal markets become subject to flexible control, instead of rigid discipline, the individual consumers are engaged in "constant monitoring of health" for themselves (Rose, 2003, p.58). Here, the transformation through new neurophamacological knowledge is noted to occur simultaneously in theoretical, economic, political, and ethical dimensions.

Here, Rose's notion of "biological citizenship" is used to indicate a complicated assemblage of humans, nonhumans, and bioscientific knowledge. For example, breast cancer patients and their families constitute biological citizenship while they share a specific understanding of human somatic characteristics—such as their shared health information, concerns and interest in BRCA genetic mutations on chromosome 13—and subsequently change their collective behaviors—such as lobbying for genetic research and collecting more information on BRCA mutation—based on the understanding. Like ANT and posthumanist analysis, the notion of "biological citizenship" does not differentiate humans, nonhumans, materials and theories in terms of their agency to produce a new network. Rose analyzed how the increasing interest in health is connected to a new way to understand human bodies and to new modes of behaviors—especially consuming behaviors—which are considered necessary for proper health management. What Rose saw, importantly, is that as biological citizenship is constituted, biomedical language is spread out from the esoteric circles to the lay public (Novas

& Rose, 2000; Rose, 2004). The public, as well as the experts, come to value the acts of visualizing and improving human bodies *through* biomolecules such as BRCA mutations or serotonin receptors in the brains.

Biological citizenship is related to a historically-specific mode of "governance at a distance," which Rose (1996) has elaborated upon "advanced" liberal democracies. According to Rose, advanced liberal democracies have several distinctive features that separate them from modern experiences. First, the powerful action of the state in "rendering intelligible the way we are governed today" (Rose, 1996, p. 38) becomes de-centered, though not eliminated. Multiple agencies including technoscientific experts—who work in government, government-aided institutes, non-governmental institutes, universities and private corporations—as well as news/advertisements, which translate technoscientific knowledge for the public and local communities (for example, the communities assembled by the members' genetic mutational susceptibilities on BRCA1 and BRCA2) in microlevels, perform as actors in making "governing" intelligible.[16] This marketized and familiarized ordering is observed in Rose's example of Prozac and Paxil instead of "the closed world of the asylum" (Rose, 2003, p. 43). Second, experts' knowledge becomes more undecidable, controversial, and a grey area, while it provides a new way of seeing in multiple locales (Rose, 1996, pp. 54-55).[17] The increased uncertainty and the loss of experts' monopoly in knowledge-production are noted as the conditions of late modernity by Beck (1992) as well. Third, as common society is pluralized and proliferates as communities, the subjects with common political reasons are re-specified as *consumers* who make *individual choices* or, more specifically, are "experts of themselves" who are educated and knowledgeable in how to take care of their own bodies, minds, forms of conduct along with those of their family members.[18] Here, Rose extended Foucault's (1980a)

[16] The aspect of *de-nationalization* or *spreading-out* was mentioned by Fraser (2003) as well when she extended Foucault's notion of discipline. Fraser named the post-fordist governmentality as flexible discipline—by flexible discipline, she means "decreasingly socially concentrated, and increasingly marketized and familiarized, postfordist processes of social ordering [that] are less likely to converge on an identifiable zone" (Fraser, 2003, p. 166).

[17] Urry (2000, pp. 34-35) has also pointed out that the truth, realities, rationalities flowing in the global fluid-society are inherently arguable, less secure, and less reliable than the ones in the territorial society. Urry went on to argue that multiple flows make "a complex, overlapping, disjunctive order within any existing society" (p. 36) and thus ultimately problematizes the concept of a coherent "society" as a valid unit of analysis.

[18] See Miller and Rose (1997) for a more general discussion on constructing the consumers as the subject of the new economy of consumption.

notion of biopower and emphasized that modern political power is "productive." Political authorities since the 18^{th} century do not enforce the choice between life and death and rather work "in the name of the well-being of the population and of each of its living subjects" (Rose, 2001, p. 17). Yet, Rose also differentiated the biopower in late modernity from earlier one by emphasizing that contemporary biopower operates more through individuals than through governmental agencies. Biological citizenship, from Rose's viewpoint, constitutes a *politics of individualization*, where the previously social phenomena of health/welfare management are reduced to individual actions.

The conceptualization of late modernity as an individualized society was articulated in other literatures as well. Anthropologist Miyazaki (2006) described the economic/financial crisis in the 1990s as an epochal incident leading to the age of individualization in Japanese labor market. In Japan, the "strong individual" *(tsuyoi kojin)* who is ready to take risks *(risuku)* and responsibility *(sekinin)* independently became the goal that a "reformed" individual should pursue. "Strong individual," who is always mindful of his market value, is markedly contrasted with the past ideal of "company man" *(kaisha ningen)*, who is dedicated to promote the collective interests of the company (Miyazaki, 2006). Miyazaki noted that since Japan's economic recession of the 1990s, "strong individuals" have come to replace "company men." The economic, political, and cultural shaping of the citizen into "responsible" individuals who can take care of their own risks is noticeable in Korea after its financial crisis as well (Song, 2007). Song argued that "neoliberal subjectification" in Korea during the Asian debt crisis from 1997 to 2001 employed the discourse of "self-management" (*chaki kwalli*) and "self-cultivation" (*chaki kyebal*)—individuals were encouraged to become deserving welfare citizen (p. 151). In the specific area of health welfare, Beck-Gernsheim (2000) also noted that in risk society it became everyone's individual task to become the expert of healthy lifestyles. The mode of governing in the late 1990s was noted by many to operate through heightened sensitivity toward risk and the ethics that individuals should become sufficiently strong, knowledgeable, and cultivated to manage their own risk.

(3) Theoretical contribution. Interestingly, Rose included that consumers, psychiatrists, hospitals, pharmaceutical companies, legal regulations all come to "pass through" neurochemicals as they constitute the so-called "psychopharmacological society" as a condition of biological citizenship (Rose, 2003, p. 57). In this sense, biological citizenship is a widely-dispersed “regime of truth” that Foucault (1980b) noted.

> Each society has its regime of truth, its ‘general politics’ of truth: that is the types of discourse which it accepts and makes function as true; the mechanisms and instances which enable one to distinguish true and false statements, the means by which each is sanctioned; the techniques and procedures accorded value in the acquisition of truth; the status of those who are charged with saying what counts as true (Foucault, 1980b, p. 131).

In Foucault’s (1980b) notion of regime, people’s discourse of what counts as truth is connected to “mechanism,” “instance,” “technique,” and “procedure” in constituting the general politics of the society. This notion of productive network was employed by Rose as he pointed out the co-production of people’s mode of behaviors and neuropharmaceuticals targeting neurorecepters at molecular level.

Rose’s account of biological citizenship as a mode of governing at distance was particular in that he emphasized the intertwining of *health-risk perception* and *understanding of bodies as molecules* in a new political order of responsible individuals. The term “somatic individuality” is used repeatedly to underline the tendency “to code one’s hopes and fears in terms of [this] biomedical body” (Rose, 2003, p. 54). Individualizing discourse in mental disorder management was analyzed *in connection with* the accumulated knowledge on how neurotransmitters and their chemical analogues work in the brain. In other words, a knowledgeable individual who constantly manages his or her risks in an advanced society is noted to emerge through (1) dissociation of individuals from the centralized government and (2) re-association of people around bioscientific materials and information.

Rabinow’s (1992) notion of “biosociality” also emphasized that individualization of risk-management goes hand-in-hand with the formation of new collective identities. Biosociality was exemplified by the emergence of new social communities such as “neurofibromatosis groups who meet to share their experiences, lobby for their disease, educate their children, redo their home environment, and so on” (Rabinow, 1992, p. 244). In the association of new biomedical knowledge and people’s new collective interests, Rabinow highlighted that it is not just “language” of biomolecular science that is expanding its realm. Certain new forms of “labor” and “life” also become associated with biotechnoscience. Flavr Savr, a tomato with significantly reduced amount of an enzyme that breaks down fruit cell walls was noted by Rabinow as a case of biosociality. This tomato that aimed to deliver firm and fresh-tasting tomatoes to consumers was advertised as "a natural alternative to artificial processing" (Rabinow, 1992, p. 248). Calgene's attempt to mass-distribute ripe tomatoes without the use of "artificial" chemical additives was accompanied by new technoscientific labor and new forms of life, where consumers negotiate what they expect from natural and artificial foods. Alhough Rabinow used the word "labor" instead of material, it is clear that through the labor of producing Flavr Savr, new technoscientific materials—such as the antisense RNA—come to take an active role in assembling consumers' concerns over chemical preservatives and Flavr Savr. It is also notable that the setting where the reconstruction of the boundary between nature and artificiality takes place is in everyday "life" where people's habits are formed. Which tomatoes to choose among the ones with chemical preservatives, with the cutting-edge antisense RNA technology, or with less firmness is potentially a question that is dealt in consumers' everyday contexts. Consumers also come to recognize their everyday life in relation to technoscience and proper modes of behavior for risk management.

Such *symmetrical* treatment of humans and materials while explaining the course of technoscientific development is the most distinct methodological characteristic of the actor-network theory (ANT). Callon's (1986) analysis of a new relationship between French fishermen and Japanese technology to protect the larvae of scallops from the predators, thus, also treated socio-economic interests and scallops as equally important allies to be enrolled and controlled in the network. Law's (1987) historical analysis of the Portuguese ship as well revealed a network *heterogeneously* composed of new navigation technology, astronomic knowledge, economic interests, and winds blowing in the Atlantic Sea. Pickering's (1995, 2005a, 2005b) posthumanist analysis of particle physics and the bubble chamber also emphasized that social agencies such as disciplinary interests are neither *a priori* nor independent from materials. Instead, they are inextricably conjoined to material agencies forming a dynamic and mutually-transformative "dance of agency" (Pickering, 1995).

By analyzing functional foods, I attempt to employ and extend the concepts of risk society, biological citizenship, and the co-evolution of human and material agencies. I argue that through functional foods provide a broader realm where the notion of biological citizenship can be extended to useful frameworks developed in STS. While Rose's units of analyses were limited to molecular understanding of human bodies, studies of functional foods will necessarily examine molecular understanding of human bodies and materials, which are essential for human health and culturally enriched life. In addition, the combination of biotechnoscience and "natural" foods takes a different form in functional foods, such as tomatoes marketed as a rich source of lycopene for prostrate cancer when compared with the one in genetically modified tomatoes or in "conventionalized" organic tomatoes. By focusing on functional foods, I expect to explicate previously unexamined processes through which the boundary between natural and artificial becomes re-constructed. Finally, the focus on functional foods includes consumers in their everyday normal settings who are important for studies on biomedicalization. Consumers of functional foods, in an attempt to reduce their susceptibility to lifestyle-related diseases, blur the boundary between the normal and the sick even more when compared with consumers of psychopharamaceutical drugs or genetic counseling. Consumers do not just purchase functional foods. They are educated by the mass media to see foods through molecular bioactive components; encouraged by the government and health organizations to constantly manage their lifestyles to maintain health; and habituated to the connection between nature, health and biotechnoscience. Through functional foods, technoscience participates in constructing new modes of behavior—not just in terms of consumption but in terms of everyday living as well. In sum, I will analyze in the following chapters the processes through which a new assembly around functional foods emerges. In Chapter 2, I will present some examples of functional foods which blur the conventional line between natural and artificial foods. I will illustrate how food industries, health risk perceived by the public, the media, and health regulations participate in the processes of constructing a new type of "natural" healthy foods. In addition, I provide a brief comparative analysis on how functional foods have been developed and regulated in the US, Canada, Japan and in Korea. In Chapter 3 and 4, I will analyze my multi-sided ethnographic findings on GBR as a particular type of functional food developed and marketed in Korea. Chapter 3 will focus on analyzing the interaction between the mass media and Korean agro-food scientists with regards to how they construct a new mode of scientific knowledge production. Chapter 4 will examine the interaction amongst the conventional media, blogs as new means of communication, and Korean consumers in domestic settings. The interaction will be analyzed to reveal the actual processes through which scientific knowledge on functional foods are combined with and intervene in consumers' everyday habits.

4. Field Sites and Methodology

The objects of analysis in this dissertation cover archival materials, elicited materials from interviews, and observation obtained from virtual ethnography. My virtual ethnography from 2006 to 2008 is an attempt to follow connections between terms, practices, metaphors and understandings related to GBR. While following the associations GBR makes in multiple online spaces, I found unexpected research objects and changed my own assumptions on the boundaries between scientific/extra-scientific, experts/amateurs, natural/technoscientific, ethical/practical, and social/material. Materials obtained from my observation of diverse websites include naturally occurring narratives in twenty online communities (including blogs run by individual consumers, blogs and web boards run by food companies, and web forums for discussion of functional foods and lifestyle-related diseases) and archival materials (including news articles in the mass media, news articles targeting scientists, governmental reports, advertisements, magazine articles, published scientific research articles, and published scientific review articles). Although I obtained and employed offline materials for my research as well, the willingness to select them as objects of contents analysis came mainly from my virtual ethnography. Most offline materials come from the interviews I conducted in 2007 and in 2008 with six Korean scientists who are currently performing academic research related to functional foods.

Virtual ethnography is not just an observation of online narratives/practices but rather a study “through and around the internet” without the assumption that “online and offline would be maintained as distinct cultural spheres” (Hine, 2007, p. 666). Without physical proximity, communities can be based on a shared sense of belonging (Anderson, 1983). In this sense, online communities are as real as offline communities; or, in other words, offline communities are as imagined as online ones (Carter 2005; Hampton & Wellman, 2001). Although virtual ethnographers do not experience physical immersion in local communities while following websites, they instead track points of connections, which are, in many cases, geographically dispersed, in a complex network (Lysloff, 2003). For example, in my research, one company blog advertising their GABA-enriched rice pointed me to a website of a research laboratory in Seoul National University and to a governmental report indicating GABA-enriched rice as a solution for elderly diseases and then to a consumers’ community contemplating upon the risks of diabetes. Although I investigated how online spheres around GBR construct a sense of belonging that was unimaginable before, my research method was not based on the assumption that online spheres in general are different from offline ones. Rather, only after investigating field sites—be it online or offline—as parts of a complicated association, I came to regard communities around GBR and GABA as a new grouping differentiated from the previously analyzed social relationships between food producers and consumers. In this sense, virtual ethnography is not about studying of "the virtual" but about understanding local spaces as technical and social relations constituted in the global flow (Wakeford, 2003).

As a subset of multi-sited ethnography, virtual ethnography problematizes conventional ethnography which is centered on the selection of a single field site based on spatial or cultural characteristics. In the single-site ethnography, ethnographers who "go native" are required to employ macrotheories to "contextualize" local knowledge obtained from the observation of local subjects (Geertz, 1973). However, local predicaments cannot be fully understood as simple ramifications of the global system. Indeed, the idea of the global "system" working as a general framework is challenged by understanding globalizations as multidimensional processes (Pieterse, 2007). Local subjects need to be studied in terms of how they are constructed and construct their contexts. Multi-sited ethnography research designs aim to analyze the circulation of objects, identities, and cultural meanings in disjointed time-space. Through following and plotting unexpected trajectories of local situations, multi-sited ethnography performatively constructs the "system" and redefines objects of study as neither simply local nor global phenomena. A clear line between the local natives and the critical mind with macrotheories does not exist in multi-sited ethnography.

Accordingly, multi-sided ethnographies are well-suited for studies of objects with no definite boundaries. My research started with the two questions of "How have chronic diseases become an important health agenda worldwide?" and "How have functional foods been constructed as a mean to reduce the risks of chronic diseases?" Both of the questions challenge the commonly accepted gap between scientific and social rationality (Beck, 1992). Consider, for example, the following excerpts from a report of a joint WHO/FAO expert consultation: "The burden of chronic diseases" is calculated to account for "approximately 60% of the 50.5 million total reported deaths in the world"; the previous naming of chronic diseases as diseases of affluence is "a misnomer, as they emerge both in poorer countries and in the poorer population in richer countries"; and the role of diets and nutrition as "determinants of chronic non-communicable diseases is well-established and they therefore occupy a prominent position in prevention activities". We can see that both scientific understanding and value-laden judgments emerge around the perceived risks of chronic diseases and the promotion of "appropriate diets" beyond basic nutrition as an urgent task both for developing and developed countries (WHO, 2003, p. 4).

Science and technology studies (STS) have been active in demonstrating that there is no obvious line between scientific and social issues. Through their examination of scientific practices and social orders as mutual constituents, STS scholars have demonstrated that what is a scientific or a social problem is subject to negotiation rather than determined by the intrinsic difference between the human and material realm (Elichirigoity, 1999; Jasanoff 1995; Latour, 1987; Shapin & Schaffer, 1985; Pickering, 1995). In so doing, they did not identify places to observe scientific practices but rather explored processes through which the spatiality of science expands to unexpected realms by following scientists, research materials and/or knowledge through society (Latour, 1988; Mol & Law, 2004). It is not surprising that Marcus (1995, p. 103) mentioned STS as a "major arena in which genres of multi-sited ethnographic research have established their importance" in his article, which is considered as a keystone paper arguing for the necessity of multi-sited ethnography.

In the previous text, Marcus (1995) suggested six "following" strategies for multi-sited ethnographers to make associations of local phenomena—following the people, the thing, the metaphor, the plot/story, the life/biography, and the conflict. In particular, Martin's (1994) anthropological research was mentioned as an example of following the metaphor of "flexible specialization," which led her to find an unexpected link between immunology and late 20th-century capitalism. Latour's (1988) study of Pasteur's biology was cited as a case of following the thing through the "inside" and "outside" of laboratories. Through the following of microbes without a grand historical narrative, Latour constructed a new framework to understand science as practices to reverse the scale of small laboratories and large societies. The two strategies, to follow the metaphor and the thing, are employed in my research. I followed the metaphor of "constant management of everyday behaviors," which was found in governmental health reports, published scientific articles, advertisements and blog entries written by consumers. I also followed what are called functional foods and molecular bioactive components in Chapter 2. In Chapter 3 and 4, I followed the movement of one specific bioactive molecule, gamma aminobutryic acid (GABA), from food scientists' laboratories, the mass media, kitchens, and online communities.

The question of whether multi-sited ethnography weakens the power of conventional fieldwork with intensive immersion has been discussed in detail by Marcus (1995). Briefly, he argued for the importance of "translation from one cultural idiom or language to another" over gaining a local lens through the researcher's immersion (Marcus, 1995, p. 100). I observed mainly three sites while following GBR—laboratories as the site to produce a particular discourse of molecular studies of foods, the mass media as the site to circulate the discourse of molecular studies and constant management of routine behaviors, and health-concerned consumers' online communities such discourses impinge on. When I interviewed professors in charge of functional-foods-related research projects, I did not immerse myself into the everyday culture of food science. I also did not aim to obtain the native voices of functional food consumers first and then to debunk what they consider as obvious. Instead, my focus was on observing specific practices, narratives, and understandings through which online/offline actors participate in constructing germinated brown rice as simultaneously a natural food and technoscientific project.

The ability to speak languages of multiple sites is important in multi-sited ethnography as well as in conventional ethnography. I have research experience in the fields of molecular biology and neuroscience. The personal experiences enabled me to understand language of food scientists and biomedical scientists in their contexts. For example, the action of GABA is known in most neuroscience texts for general education as an "inhibitory" neurotransmitter. Yet, it was important to understand that the physiological effects of a neurotransmitter *in vivo* are actually much more complicated than the electric effects of a neurotransmitter detected *in vitro*. I also had local knowledge as a Korean. I understood not just food scientists' fine-grained knowledge but also their contexts because I had a personal experience in Korean university laboratories and in a biotech start-up company between 1999 and 2002, when Korean scientific research environment was changing in relation to the increased governmental budget for basic scientific research. When two Korean professors that I interviewed told me how their research transformed after the 1990s, I understood that their experiences were situated in a broader change in Korean policy for scientific research and development.

However, I do not regard myself as just a native who understands language and contexts of scientists. Again my strength as an ethnographer comes from my readiness to see connections between different field sites. I examined not just scientists' narratives and published scientific research materials. I also analyzed mass media texts/images, policy reports evaluating research on functional foods, and consumers' accounts observed through and around the internet. From my empirical observation, I was unable to see the workings of a global order overarching multiple sites. Instead, I could see the focus on "everyday" and "molecule" constantly appear in the on-/offline associations around GBR. Attention to the links that I found between multiple sites differentiates my research from previous sociological discussion on functional foods under the general perspectives of food industrialization.

It is important to note that multi-sited ethnography is not a research method aiming for controlled comparison of different field sites. In my study, for instance, I "compared" the practices of food scientists who transform germinated brown rice into rice with an enhanced amount of GABA through their material, organizational and conceptual apparatuses with the ones of journalists who make simplified narratives on GBR and GABA. However, I did not, from the beginning of my research, have the assumption that food scientists and journalists are homogeneously conceived conceptual units. Food scientists, depending on contexts, participate in producing simplified accounts of scientific knowledge. Besides, there is no such thing as "the media's tendency" in reporting scientific information on the health benefits of functional foods—suspicion, critiques and propagandas are all found in the mass media coverage. I could begin to make specific comparison between Korean and the US. mass media' handling of GABA working in the brain only after I followed the connection between research practices in neuroscience laboratories and food science laboratories. Their specific differences I observed, in turn, enabled me to compare food scientists and the mass media while simultaneously recognizing their interactions to construct GABA as a bioactive component in GBR. In this sense, de facto comparison emerged as a result of discovered associations among multiple sites.

Multi-sited ethnography is also not about representing the voice of the subaltern, which is regarded as the key strength of the physically immersive ethnographic studies. Marcus (1995, p. 101) argued that the strength of ethnography does not necessarily have to reside in "focuses upon subaltern subjects positioned by systemic domination ultimately traceable to capitalist and colonialist political economy." Such renunciation of "the subaltern perspectives" is related to the suspicion over privileging a single site for ethnographic research. My research did not examine, for example, farmers and health/environmental activists having the ideal standards on minimally processed foods or local coalition between food producers and consumers. Instead, I examined material, discursive and organizational associations that are actually formed around the particular things—GBR and GABA—with distinct meanings attached depending on locales. By so doing, I moved away from the general framework of the global food capitalism which has organized a considerable body of valuable research in food-related studies.[19] Instead, I examined a particular network, which is not shared by everyone but reveals the processes through which functional foods reconstruct conventional boundaries between scientific/social, experts/amateurs, and natural/artificial. To quote Marcus (1995, p. 101), "Multi-sited ethnography does not merely add perspectives peripherally to the usual subaltern focus—e.g. adding perspectives on elites and institutions, or studying 'up' for mere completeness. Rather, this kind of ethnography defines 'a new object of study.'" The strategies of multi-sided ethnography to follow things and metaphors enabled me to map an ambiguous realm—natural and healthy foods consumed in everyday diets as a means to reduce risk of chronic diseases—as an object of study.

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[19] See, for example, Klappenburg (1988), McMichael (2000), and Schurman (2004)

CHAPTER 2
FOOD, TECHNOSCIENCE, THE MEDIA, RISK AND GOVERNMENT

1. New Interests in Natural Foods

The growing consumer demand in natural foods has been noticeable since the late 20th century. According to the Organic Trade Association 2006 Manufacturer Survey, sales of organic foods in the US have shown consistent annual growth rates of 15% to 21% since 1997 accounting for total market value of $13.8 billion in 2005. On the other hand, “artificial” foods, such as GMO (genetically modified organisms) and mass-produced foods with pesticides, preservatives or growth hormones are regarded to threaten public and environmental health in modern society (McMichael, 2000). In such circumstances, it is not surprising that consumers in general hold dichotomous understanding of natural-and-local-and-trustworthy-and-safe vs. artificial-and-industrialized-and-global-and-threatening foods (Lockie, Lyons, & Lawrence, 2000).

In Chapter 1, I reviewed several previous studies that examined the processes through which some foods become generally understood as “healthy.” In particular, sociological literatures have paid much attention to the construction of “conventionalized” organic foods that deviate from the ideal of organic foods. Notably, Hess (2004) analyzed the construction of organic functional foods as the processes for the food industry to embed organic foods into an ambiguous category of healthy or natural foods. Here functional foods are understood as a part of “conventionalized” organic foods that undermine the original social/political goals of organic food movement. Unlike “conventionalized” organic foods, the ideal organic food-agriculture is regarded as an “expressed criticism of modern food-agricultural technology” (Michelsen, 2001) or as “evidence of reflexive modernity” (Kaltoft, 2001).

This chapter criticizes the tendencies to analyze new types of natural or healthy foods in late modernity based upon the normative assumption that natural foods are *supposed* to be an opposition against technoscientific or “artificial” foods of modern industry. Let me start by demonstrating that it is difficult to be characterize functional foods as “industrial”, “natural” or conventionalized natural” foods.

Functional foods are loosely defined as “foods and food components that provide a health benefit beyond basic nutrition”. The definition devised by the Institute of Food Technologists

(IFT), an international society for food science and technology is shared by the US Food and Drug Administration (FDA), the National Food Authority and the American Dietetic Association. Then, what types of "natural" foods are included in the category of functional food? The International Food Information Council (IFIC) foundation, which is supported by food-agriculture industries to communicate information on food safety and nutrition to educators, journalists and consumers, gives a list of functional food examples that "people should strive to consume" (International Food Information Council [IFIC], n.d., p. 4). The examples listed on the IFIC website include food sources of the components, active components, and their potential health benefits combined—including lycopene in tomatoes for prostate health, beta glucan in oat bran for coronary heart disease (CHD), docosahexaenoic acid (DHA) in salmon for CHD, mental and visual functions, flavonols in broccoli for neutralizing cell-damaging free radicals, anthocyanins in berries for bolstering antioxidant defenses and brain functions and etc. According to a summary of web seminar held by Nutrition Business Journal in February 2006, functional food sales account for 4.5% of the total food sales ($544 billion) in the US. Sales of functional foods increased by 6.8% in 2004 compared to only 1.6% for total food sales (Nutrition Business Journal [NBJ], n.d.).

Still, what is and what is not included in the category of functional food is not so straightforward. The US Food and Drug Administration (FDA) and the Institute of Food Technologists (IFT) include foods, food components and dietary components all in the category of functional foods as long as they provide a health benefit beyond basic nutrition. Yet Agriculture and Agri-Food Canada (AAFC) defines functional foods as "similar in appearance to, or may be, a conventional food, [which] is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions" (Agriculture and Agri-Food Canada [AAFC], n.d.; Kleter, van der Krieken, Kok, Bosch, Jordi, & Gilissen, 2001, p. 1006). The definition by AAFC emphasizes "part of a usual diet" and excludes purified bioactive components (such as vitamin capsules or other dietary supplements) from the category of functional foods. According to the definition by AAFC, purified bioactive components are not functional foods but "nutraceuticals". To increase the confusion, however, nutraceuticals can also refer to "*foods, or parts of foods*, that provide medical or health benefits, including the prevention and treatment of disease" as a catch-all term (Brower, 1998).

Yet more confusion is present around "modification." According to Thomas and Earl, functional foods include "any *modified* food or food ingredient" if they provide a health benefit beyond that of the "traditional nutrients" they contain (Thomas & Earl, 1994). In this case, canola, which is developed through breeding from rapeseed to contain lower amount of erucic acid, is a functional food because erucic acids have been arguably associated with health concerns in babies. When "modification of traditional nutrients" in natural foods is done by genetic engineering rather than by traditional breeding, things get more controversial still. In that case, functional food comes to include GMOs and gets associated with GMO controversies as well. Transgenic pigs enriched with omega-3—which is expected to lower the risk factors for "cardiovascular disease, cancer diabetes, and Alzheimer diseases", have been an area of controversy (Kang & Leaf, 2007). While several scientists are confident that "bacon and pork chops that might help your heart" will eventually reach to American consumers, some argue that "government approval for such genetically modified foods is certain to face monumental opposition from some consumer groups" (Kolata, 2006).

We could broadly categorize functional foods as below.

1. Inherently healthy functional foods: Natural and whole foods with scientifically-proven health benefits beyond basic nutrition. (e.g.,, tomatoes, salmon or oatmeal)
2. Purified functional foods: Bioactive components extracted and purified from natural foods (e.g., DHA capsules sold by the Sagami Research Center which made $1.28 million sales in the year of 1993) (Swinbanks, 1993).
3. Fortified functional foods: Whole foods which were modified or fortified by agricultural, chemical and/or genetic methods to have more health benefits than their original forms (e.g.,, canola oil, omega-3 enriched pigs, probiotic enriched yogurt, or the "golden rice" developed by Syngenta with its enriched amount of beta carotene) (Ye, Al-Babili, Klöti, Zhang, Lucca, Beyer, & Potrykus, 2000).

In Table 2 that lists examples of "foods enhanced to have more of a functional component," "isolated, purified preparations of active food ingredients," and "processed foods with added ingredients" provided by AAFC, the differences among these three categories seem reasonably clear. While the second and third categories are not separable from the modern technoscience, the first category is likely to be considered as genuinely "natural" foods. However, what happens during the actual development and marketing of functional foods makes this reasonable categorization implausible in practice. Functional foods are usually used as a catch-all term in the newspaper articles and advertisements that most food consumers come to read. In sum, functional foods are natural or modified food or food stuffs with scientifically proven health benefits.

Importantly, this chapter is not an attempt to expose “artificial” components/processes involved in the current making of functional foods. I do not aim to criticize some functional foods by comparing them with a certain ideal of what natural and healthy foods *should* be like. I do not aim to present some functional foods such as beta-glucan-enriched whole-grain cereals full of sugar to argue that some junk foods are marketed under the packaging of healthy foods. Rather, I seriously consider the existing confusion or conflicts over the question “what is a natural food,” and aim to analyze the processes through which such confusion and conflicts develop. Why is the question becoming more difficult to answer? In other words, through what social, discursive and technoscientific processes are the hybrids of the natural and the artificial foods produced and maintained? To pursue this question, I analyze diverse cases where a relatively new notion, “functional food” comes to include both natural and artificial components.

This chapter consists of two sections. In the first section, I present an international comparison of how functional foods were developed in an attempt to reveal the social and cultural contingencies in constructing functional foods as a regulatory object. I will make comparative accounts on functional food development in distinct regions—including the US., Europe, Japan and Korea. With the international comparison, I aim to further clarify how functional foods work as a site to analyze *new* social and technical processes through which foods become biomedicalized (Clarke, et al., 2003). In the next section, I analyze the processes of food biomedicalization and their implication through following three key actors—(1) the perceived health risks caused by mass-production and industrialization of foods (2) biotechnoscience which provides the information on “molecular bioactive components” in natural foods and (3) governmental health policies urging individuals to take care of their own lifestyles.

2. Functional Foods: International Comparison and Analysis

Functional food itself might be merely seen as another “nutritional *Elixir vitae*” that came after vitamins in the 50s, proteins and amino acids in the 60s, cholesterol lowering dietary supplements in the 70s, and dietary fiber in the 80s (Hulse, 2004). The human desire for nutritional *Elixir vitae* itself most likely dates back to the era of Hippocrates. However, it is important to note much closer connection between functional foods and biomedical experts' communities compared to other "healthy" foods, as I discussed in the previous chapter. Claire Hasler, who wrote the position paper on functional foods for the American Council on Science and Health in 2002, noted that the main difference between functional foods and older philosophical notion of "food as medicine" lie in the functional food research focusing on reducing the risk of particular chronic diseases such as heart disease, cancer, osteoporosis, diabetes and strokes (Hasler, 2002). There are numerous clinical trials evaluating the impact of various food components on health, for example, ability of organosulfur compounds in garlic to reduce cholesterol levels; experiments with spinach to establish if its lutein can reduce risks of age-related macular degeneration. In this sense, technoscientific practices take new forms to intervene in natural foods. Technoscience for foods is no long limited to the industrial production of risky food contaminants but instead is extended into the molecular re-discovery of "natural" and everyday consumable foods through functional foods. Potentially, any type of natural foods can become a subject of molecular re-discoveries. Management of diets, which previously belonged to the non-medical dimensions of life, evidently has become subject to biomedicalization mediated by multisided social and technoscientific practices.

How did such changes occur almost simultaneously in Japan, the US., Canada, Europe and Korea after the late 1990s? In this section, I will briefly illustrate the history of functional food development in various regions first and then add my analytical remarks.

> *During the late 1990s* the food industry has enthusiastically, almost evangelically, come to embrace the whole new concept of functional foods—foods and beverages that may provide health benefits beyond basic nutrition, and which have been termed 'nutraceuticals' in the US. Many scientists describe the developments in functional food science as standing 'at the threshold of a new frontier in nutritional sciences'. Functional food science is already being actively commercialized and promoted to health-conscious consumers around the globe (Heasman & Mellentin, 2001, emphasis added).

Many food/nutritional scientists claim are in agreement that the late-1990s mark a notable tipping point for the emergence of functional food. In 1991, Japanese Ministry of Health and Welfare started to legally approve certain foods to be commercialized as Food for Specified

Health Use (FOSHU). This was the first policy in the world that permitted the presentation of a specific health benefit for foods. In 1993, the first FOSHU product "fine rice" was approved after clinical trials with more than 40 volunteers having rice-associated allergy (Arai, 2007). This first FOSHU was produced through an enzymatic treatment of grains to remove allergens from the globulin part of rice proteins. This hypoallergenic rice was soon followed by many other FOSHU products with characteristic "functional factors" from natural food sources. For example, after biomedical characterization and clinical studies with oligopeptides called IKP in dried bonito, two fermented soybean soup products containing dried bonito were approved as FOSHU with anti-hypertensive activity. On May 3 1994, Tsutomu Konno and colleagues obtained the US patent No. 5308618 entitled as "dietary fiber extracted from wheat bran pharmaceutical and dietary compositions containing same". In the patent application, the inventors stated that dietary fiber obtained from wheat bran possesses "antitumor, cholesterol metabolism improving and immunological activities *in addition to usual physiological activities of dietary fiber*" (emphasis added).

It is noted that functional food related research started earlier than the legalization of FOSHU. In 1984, the Ministry of Education, Science and Culture (MESC) in Japan began to sponsor a national project "Systematic Analysis and Development of Food Function" in an attempt to systematically study the relationship between food and health benefits beyond basic nutrition. The Japanese government's interests in functional food are connected to the country's demographic and social change in the 1980s. After two decades of high economic growth, Japanese society had already solved problems of food shortage after World War II and instead suffered from sudden increases in the diseases of the aging population such as hypertension, arthrosclerosis, diabetes, cancer and so on. With the support from the MESC project, food scientists came to have a novel research goal—to find disease-preventing factors from natural foods. During the 1980s and 90s, various food components were characterized as disease-preventing through clinical trials were used as ingredients of FOSHUs in Japan (see Table 3). Whilst Ministry of Health and Welfare approved many FOSHU products that were claimed to alleviate the symptoms related to so-called "degenerative diseases" of the aging population, studies on functional factors were continuously supported by the subsequent MESC projects—Analysis of Body-modulating Functions of Foods project (1988-1991) and Analysis and Molecular Design of Functional Foods project (1992-1994). From the beginning, Japanese government's goal to improve the health of the nation's aging population was highly influential in the research and development of functional foods.

In the US, the 1997 Food and Drug Administration Modernization Act is noted as an important point for functional food development. The act allowed a health claim for a food to be presented if based on "an authoritative statement of a scientific body of the US government or the National Academy of Sciences". In 1999, after the implementation of the Act, the US Food and Drug Administration (FDA) permitted labeling foods containing soy protein as reducing the risk of coronary heart disease. The FDA based this decision on clinical studies demonstrating that at least 25 grams of soy protein a day as part of a diet lowered cholesterol levels, which reduces the risk of heart disease. Numerous studies performed during the 1990s on a wide range of natural whole foods—such as cabbage, onions, garlic, celery, cucumber, endive, parsley, radish, and legumes—have indicated their specific health benefits (See Table 4)[20]. In addition, more than five hundred "bioactive food components" in natural fruits and vegetables have been characterized as "potential modifiers of the cancer process" during the late 1990s (Milner, 2002). Although the US still does not have the legal category equivalent to Japanese FOSHU and consequently, the term "functional food" is used for various products (sometimes including dietary supplements or genetically modified foods), the concept of natural foods and their components consumed as a part of a regular diet for specific health benefits seems to be emerging in the US. Even though the US market size of functional food (such as cereal containing fibers from oat bran) has been often estimated in combination with dietary supplements (such as fibers from oat bran in capsule forms) or with general natural/healthy food products (such as any types of fiber-rich foods) due to the lack of a strong regulatory system, it is clearly unreasonable to argue that functional food takes the same developmental pathways as dietary supplements in the US. Scientists' tendency to pay special attention to disease-preventing qualities of natural foods can be observed in the US as well; and it needs to be analyzed separately from the processes of constructing dietary supplements or other healthy products.

Unlike the US scientists, food scientists associated with the European body of International Life Science Institute (ILSI) participated actively in developing a European consensus on "Scientific Concepts of Functional Foods". Since 1996, Food scientists in ILSI Europe

[20] For summarized results of functional food-related research during the late 1990s, see Milner (1994) and Potter & Steinmetz (1996).

coordinated the establishment of the European Commission's Concerted Action on Functional Food Science in Europe (FUFOSE). In 1998, ILSI Europe made a statement that the development of functional food marks a conceptual change on foods where emphasis on alleviating hunger is replaced by "*reducing the risk of chronic illness* through diets" (Bellisle et al., 1998, emphasis added).[21] In 1999, a consensus document proposed a working definition of functional foods as follows:

> A food can be regarded as functional if it is satisfactorily demonstrated to affect beneficially one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either *improved stage of health and well-being and/or reduction of risk of disease*. A functional food *must remain food* and it must demonstrate its effects in amounts that can normally be expected to be consumed in the diet: it is not a pill or a capsule, but *part of the normal food pattern* (Diplock, Aggett, Ashwell, Bornet, Fern, & Roberfroid, 1999, emphasis added).

This working definition provided by European scientists associated with the ILSI bears much similarity with Japanese definition of FOSHU. The notion of "reduction of risk of disease (especially chronic disease)" through "normal food" apparently separate functional foods from vitamins or other dietary supplements used for therapeutic purposes. Simultaneously, the emphasis on "satisfactory demonstration" of health benefits separates functional foods from general healthy foods.

Unlike the regulatory and research initiatives surrounding Japanese, the US and European functional foods, the contexts of Korean functional food development has not been discussed so far in Western academic journal. To conduct the present study on Korean functional food development, I resorted to various policy reports written by Korean governmental agencies or government-supported research institutes. "Development of Web-based Database for National Research Project on Health Functional Food" (Kim, 2007) was written as a project report for Korean Food and Drug Administration (KFDA), whilst "Gineungseong sikpumsaneop sijanghyeonhwang mic cheonyoenmur sojae yeongugaebal [The Market Trends of Functional

[21] *British Journal of Nutrition* published a supplementary issue on functional food in 1998 with six research articles. In the foreword, it is stated: "We stand today at the threshold of a new frontier in nutritional sciences. The concepts of food are changing from a past emphasis on survival, hunger satisfaction, absence of adverse effect on health, and health maintenance to an emphasis on the promising use of foods to promote better health and well-being, thus helping to reduce the risk of chronic illnesses such as cardiovascular disease, some cancers and obesity" (Diplock, et al., 1999).

Foods & Research and Development for Natural Functional Components]" (Kim & Kim, 2009) was written by Biotech Policy Research Center affiliated in Korea Research Institute of Bioscience and Biotechnology (KRIBB). "Gineungseongsikpum sijangdonghyang [The Market Trends of Functional foods]" (Chang, Park, & Ha, 2003), "Choegeun cheonyeonsojaereur iyonghan geonganggineungsikpum gwanryeon teukheodonghyang [Recent Trends in Patent Application of Functional Foods Made from Natural Products]" (Park, 2004) and "Gineungseongsikpumui hyeonhwanggwa jeonmang [The Market Trends of and Perspectives on Functional Foods]" (Moon, 2009) were written by Korea Institute of Welfare Industry affiliated in Korean Ministry of Health and Welfare (KMHW). "Gineungseong nongsikpum teukheodonghyang [Trends in Patent Application of Functional Agri-Food]" (Korean Intellectual Property Office, 2009) was published as a project report for Korean Intellectual Property Office. "Geongangsikpum mic geu gineungseong yeongudonghyang [Research Trends in Functional Foods and their Bioactivities]" (Korea Institute of Science Technology and Information, 2005) was written as the institutes' research project report. Heo (2009) in Korea Institute of Rural Economy wrote a summary report on "Juyo gukgaui gineungseong sikpumsijang hyeonhwang [Trends in Functional Foods in Major Countries]".

Analyses of the above reports revealed that Korean food scientists make no notably different remarks in terms of functional food. The common emphases on chronic illnesses of the aging population and scientific demonstration of health benefits are frequently observed in Korean policy reports written by food scientists and regulatory bodies. It is hard to find specific events marked as starting points of functional food development in Korea. There can be several reasons for such lack of historical accounts in Korean functional food studies. Firstly, similar to the US, Korean Food and Drug Administration (KFDA) provide specific regulations for dietary supplements but not for functional foods consumed in regular dietary forms. Thus, it was often noted that Korean research on healthy "dietary supplements" increased sharply after the establishment of the Health Functional Food Act (HFFA) in 2002, since the act legally permitted the presentation of specific health claims of dietary supplements—it needs to be noted that the legal name of dietary supplements in Korea is "health functional food (Gun-gang-gi-neung-sik-pum)," although they are not in the form of regular foods. Similar to the European situation, some Korean scientists provided working definition of "functional foods (Gi-neung-seong-sik-pum)" in an attempt to differentiate functional foods in regular diets from "health functional food". Still, it is difficult to mark a tipping point for functional food development in Korea because Korean functional food does not exist as a well-defined category yet. Secondly, an implicit assumption that developmental pathways of dietary supplements and functional foods overlap is often made. Consequently, some reports make claims that functional food development in Korea increased after the late 90s or after 2002 based on statistical analyses of dietary supplements developed, approved or patented in these periods.

Here it needs to be pointed that Korean dietary supplements (or "health functional foods," as they are called in Korea) are different from the US equivalents. Among 38 categories of dietary supplements approved by KFDA, 19 categories are defined by their natural *food* sources although they take the non-food form of capsules, tablets, powder and etc. For example, dietary supplement categories are designated by KFDA as "mushroom products," "plum extract products," "grapeseed oil products," "germ oil products," "eel oil products," "products with soybean protein," and so on. Relatively small number of dietary supplement categories is defined by their chemical names and designated as "products with EPA/DHA," "products with chitosan," "products with alkoxyglycerol" and so forth. In such circumstances, it is reasonable to simply assume that growing research interests in health benefits of natural foods coincided with the market expansion of dietary supplements without further historical examination. Thirdly, many policy reports state that Korea is a few years behind "advanced countries" including Japan, the US and Europe in terms of functional food development. Historical accounts on early functional food development typically introduce the contexts of the three advanced countries with temporal details and then view Korea simply as a late-comer. Generally, it is noted that interests in Korean dietary supplements have increased after the mid 1990s affected by Japanese trend, and had a short period of decline between 1997 and 1999 during the nation's financial crisis. The interest increased again after 2000, and then reached the highest point in terms of sales in 2003 (estimated as $1.3 trillion Won or about $13 billion USD). It can be argued broadly that interests in Korean functional foods have increased (at least) after the establishment of HFFA in 2002. For particular functional foods in the form of Kimchi or other fermented vegetables, it is recorded that scientific research on physiological activities started as early as in the early 90s. In 2003, rice with larger germs developed by Ko, Hee-jong and colleagues through selective breeding was listed as one of the 100 exceptional projects in the National Research Program (NRP). In the summary report of the 100 exceptional projects published by Korean Ministry of Science and

Technology (2006, p. 141), the rice was introduced as "rice with more GABA which enhances neuronal metabolism," "functional rice which can be consumed every day to reduce the risk of degenerative diseases" and "rice which can reduce the consumption of dietary supplements or pharmaceutical products." The summary of the research findings on rice with bigger germs clearly indicates Korean government's interests in functional foods in *regular diet forms* and their activities in promoting health especially in the aging population of Korea. In summary, though historical accounts on when functional food development began in Korea are lacking, it seems reasonable to argue that Korean functional food development has taken the similar pathways to Japanese, the US and Europe, albeit with a few years of delay.

Another thing in common between Korean functional foods and those from other regions is in their practical emphasis on "natural" foods. Korean mass media also seems to favor natural functional foods over artificial ones. From 349 news articles published between 2004-02-01 to 2006-12-31 containing the word "bioactive components (Gi-neung-seong-seong-bun)" in foods, 300 articles introduced molecular bioactive components along with "enhanced" types of functional foods and only 49 articles covered "artificial" types of functional foods such as sparkling water enriched with vitamin C or L-carnitine—a weight loss dietary supplement. Enhanced types of functional foods frequently covered in Korean news articles included milk (milk with more absorbable calcium appeared 23 times), fruits (varieties with various phytochemicals appeared 31 times), rice (34 times), soy (26 times), fish/seafood (27 times), vegetables (50 times) and herbal drinks (20 times). In all the above Korean news articles covering functional foods, the focus is not on "single constituents in foods for health [which] contrast traditional wisdom" as Holm (2003) noted.[22] For example, one news article introduced beta-carotene enriched bakchoi as a functional food to prevent cancer, whilst emphasizing that the bakchoi was produced in a rural region through plant breeding and that the backchoi would

[22] Like the media articles, Korean research papers on functional foods also highlight the health benefits of natural *whole* foods consumable in *everyday diets* as the source of bioactive components. Park and Yee's (2000) quantitative analysis of Korean research papers published in *Hankook-Shik-Pum-Yong-Yang-Gwa-Hak-Hoi-Ji* [Journal of Korean Food and Nutritional Science] shows that bioactive components in soy appeared in published papers 19 times. Red peppers, onions, mustard green and ginseng appeared more than 10 times. Pine leaves, green tea, persimmon, mushrooms, dates, Crepidiastrum sonchifolium, garlic, squash, Angelica keiskei appeared for five to nine times. Licorice, kudzu, mustard, Ligularia fischeri, Salvia miltiorrhiza, Polygonatum odoratum, buckwheat, Ixeridium dentatum, Asteraceae, ginger, Lingzhi mushroom, Cirsium japonicum, Houttuynia cordata appeared more than three times. All of the above mentioned plants can be used for common foods or beverages in Korea, except Salvia miltiorrhiza and Lingzhi mushroom which are used mainly for the preparation of herbal medicine.

go well with meat because beta-carotene is oil-soluble. Here functional foods and bioactive components are described as a kind of local agricultural products popular within Korean food culture—many Koreans have a habit of wrapping meat in leaves. At least, it seems difficult to argue that, both in Korea and in the US, functional foods that "appear as if they emerged entirely from a laboratory" are taking the major proportion of functional foods produced and marketed.

Overall, functional food is understood in a broad range of regions as a natural whole food which can reduce the risks of chronic diseases and provide health benefits beyond basic nutrition. Yet how can it work as a site to observe and analyze new processes of biomedicalization? Here I will begin my brief analytical commentary to contrast the general pathway of functional food development with those of other "healthy" foods mentioned in the introductory chapter—organic foods, safe foods and vitamins. In doing so, I will use Pickering's (2005b) analytical terms and frameworks employed in his historical accounts of the emerging synthetic dye industry. From my perspectives, functional food research in the late 1990s and the synthetic dye industry in the late 19^{th} century share many common themes. During the 1990s, food science was closely connected to scientific/clinical projects of *finding* bioactive (or functional) components in natural food sources. In other words, food science became the means for "scientific and healthy," rather than "organic" or "safe (such as GM-free)" food production. Through functional food research, natural foods were connected to governmental bodies for bioscientific research (such as the Nutritional Science Research Group (NSRG) in National Cancer Institute's (NCI) Division of Cancer Prevention) and health-related research (such as the MESC projects and part of the Korean NRP). Functional food research projects, in my view, are comparable to the synthetic dye production where dye manufacturing was "connected not to traditional producers of animal and vegetable raw materials, but to tar distillers" and led to "a transformation of *social ontology and topology*" (Pickering, 2005a, p.366, emphasis original). To employ Pickering's terms, functional food production can be regarded as a new entity appearing on the social landscape of the post-1990s. Functional food marks a transition where *natural foods* came to be primarily connected to food-science research on bioactive components rather than to other processes such as local producer-consumer coalitions, processes of conventionalization by the food industry, or the mass media emphasis on the "absence" of risky materials (such as organic milk advertisements emphasizing the absence of genetically recombined bovine growth hormone in it). The connections between natural foods, scientific research and bioactive components have not been noted in the previous literatures on organic, conventionalized (industrial) organic or safe foods, as discussed in the introduction. Functional food also bears an important dimension discussed insufficiently by the previous studies on vitamin therapies—the processes through which biomedicine incorporates foods as their subjects.

Three important analytical concepts are used in Pickering's accounts of the synthetic dye industry—emergent material phenomena, translation and tuning. The synthetic dye industry started with the discovery of a new way in which materials behaved, for instance, the coal-tar fraction toluene used as the starting material for mauve dye. In a sense that the way toluene performs for the synthesis of mauve could not have been socially structured to appear, this particular material phenomenon *emerged*. Yet this emergent material phenomenon did not produce a new industry in itself; instead, a *translation* of the mauve recipe from the small laboratory to the industry followed with the goal of large-scale production of synthetic dyes. Here the goal of translation for mauve could have been structured by social interests in developing the pharmaceutical industry with new synthetic methods. Pickering emphasizes that the goal of translation could be structured by social interests in developing the dyeing industry only because the alignment of mauve recipe and the dyeing industry was produced, rather than prescribed, through active processes. During the processes of producing a particular alignment, the industrial dye production was *tuned* into the social elements of mauve synthesis. Overall, the above analysis provides useful terms for the examination of "a coupling of the technological to the social, [while] the becomings of the technological and of the social hang together and *interactively stabilize* one another" (Pickering, 2005b, p. 369, emphasis original), which, in my view, is what occurred in the unprecedented coupling of natural foods, scientific research and social strategies to reduce the risk of chronic illnesses.

During the development of functional foods, a number of "functional/bioactive components" were characterized in natural food sources. In a sense that Japanese society could not predict in advance that chitosan in crab and shrimp shells will lower blood cholesterol levels, such discovery was an *emergent* material phenomenon. Korean society also could not know in advance that rice germs, instead of rice grains, possessed bioactive components with diverse health benefits. Nonetheless, such material phenomena in themselves were not destined to be connected to a national-scale functional food research or a goal of health management of the aging population. It is likely that the case that the characterization of food-originating bioactive components was connected to the chemical synthesis of such components and led to the growth of the dietary supplement industry. Hess's (2004) brief analysis of functional food as a branch of the dietary supplement industry incorporating organic foods focuses on that particular direction of tuning natural food into the social structure of the US. Yet many researchers, regardless of different national contexts, kept their research goals of investigating bioactive components obtained from *natural* food sources. Along with that, working definition of functional food came to be proposed in various locations with a reference to "normal food" forms. In a more specific case, it was possible that the biomedical studies on rice-originating GABA were connected to the production of genetically modified rice with more GABA. However, the current Korean functional rice market is dominated by natural brown rice of which amount of GABA can be increased through household processes of germination. On another note, it was possible for the biomedical community or for consumers to show little interests in food-originating GABA, fibers, polyphenols etc. Yet I argue that since the 1990s, multiple, multi-sided and multi-directed processes emerged with the aim to strengthen the post-industrial connection between natural foods and high-tech biomedical science. This notion is distinct from the previous connection between natural foods and industrial processing or the object conflicts between organic food movement and the food industry, as Hess (2004) has analyzed. The active processes will be discussed in detail in later chapters. Here I note that the development of the functional food represent a *tuning* of natural foods with health benefits first into the research practice of the high-tech biomedical science and then into consumers seeking to reduce their health risks through regular diets. Importantly, the previous studies on functional foods or other foods generally recognized as healthy have not addressed the question of "how natural foods become biomedicalized with the multiple notion of being healthy, scientific and natural". Although functional food can be perceived as an extension of the age-old notion, "let thy food be your medicine," I argue that analysis of functional food as a separate category is necessary in order to examine the new transformation of natural foods after the late 1990s.

As discussed in introductory chapter, previous sociological analyses of functional foods focused on industrialization of natural/organic foods through isolated healthy components. Such perspectives, which mainly focus on the socio-political consequences of the corporate power's appropriation of nature and local agricultural communities, are inadequate for the analysis of functional foods. As the brief examples of backchoi suggest, desire for natural whole foods is not simply lost in or separated from the technoscientific processes of finding/enriching bioactive components in functional foods. Figure 2 shows that images of functional foods found in the US media also frequently feature colorful whole foods with roots, leaves, peels and everything that is intended to indicate "natural" foods. Images of refrigerated broccoli or canned fish are not to be found in academic journals, news articles or advertisements of functional foods. To analyze how the image of "clean living cows" with the graph indicating higher contents of omega-3 is understood by functional food consumers, new approaches are necessary. As Murdoch et al. (2000) argued, the growing consumers demands for quality, safe, healthy and natural foods are not "easily rendered into the vocabulary of political economy."

Previous studies on functional foods are also limited in the discussion over how functional food obtained its status as a scientific solution to chronic diseases in the specific social/cultural/biomedical context of the post 90s. Firstly, we need to focus on the fact that most diseases claimed to be preventable by the regular consumption of functional foods, such as heart disease and diabetes, are caused by over-nutrition rather than nutrient deficiency. Secondly, whilst the success of modern medicine causes the aging of the population, the current medical progress is far from eradicating the aged population's chronic diseases that are increasingly becoming the major health problem. Third, the civil society and sometimes medical professionals are increasingly expressing their concerns and suspicion over financial motivation of the mainstream biomedical communities (Hess, 2004). In sum, the growing concern for chronic diseases as a challenging problem for modern biomedicine can be understood as a part of a broader social transformation that Beck (1992) noted as reflexive modernization, where people become critical of the progressive claims of modernity. Yet no sociological analyses so far have examined functional foods—proclaimed to be the solution for chronic diseases by food scientists in general—to analyze the condition of reflexive modernity.

Meanwhile, several previous studies have examined the processes through which some foods become generally understood as "healthy." In the construction of "conventionalized" organic foods, the processes of embedding organic foods into the broader category of healthy or natural foods were understood as debilitating the original social/political goals of organic food movement. In the studies of "safe" foods, the processes of situating non-GM or non-artificial foods within "not-in-my-body" risk politics were mainly analyzed in the cultural realm without much attention to the dynamics between technoscientific practices and social perception of "safety". Finally, in the analyses of vitamin and dietary cancer treatment, technoscientific practices of vitamin research/production were examined in relation to the mainstream biomedical community's attempts to exclude them from the realms of biomedical research to those of health social movement. In sum, although previous works in sociological studies have analyzed some "healthy" foods and their social implications, this dissertation is the first attempt to empirically analyze through what processes natural foods with health claims become the object of biomedicalization.

In the next sections, I will clarify how biomedicalization of natural foods amplifies confusion and conflicts around the line between "natural" and "artificial" foods. I will start by examining the contact between the perceived health risks of industrial foods and scientific knowledge on the molecular bioactive components. I will then examine how governmental health policies on lifestyle-related diseases spread simultaneously the perceived risks and molecular understanding. Finally, I will add my analytical remark on the blurred boundary between natural and artificial foods.

3. Living in Risk Society: Risks Meet Bioscientific Knowledge

Modern food science and technology in the 19th and 20th century are considered as one of the major arenas where the systematic industrialization and technical manipulation of nature have been carried out. Chemical fertilizers, massive food processing industries, food additives and more recently, genetic modification have constituted the history of artificial adulteration of natural foods, which have gone along with the history of urbanization/industrialization (Goodman & Redclift, 1991; Mintz, 1985).[23]

Material and social construction of modern food industry have been accompanied by discourses. Whilst various technical methods were developed to transform natural foods into a mass-commodity, so was the discourse to understand mass-production of foods as "benefits" for the public.

[23] Goodman and Redclift (1991, p. 279) summarized the hand-in-hand processes of food industrialization and urbanization as "food into freezers, women into factories."

Some effort is currently being made to market natural foods, i.e., those that are relatively free of chemicals not put there by mother nature, and thereby cater to the desires of consumers who have apprehensions about food additives. However, two forces provide powerful incentives for increased use of food additives. First, urbanization is extensive and continues to increase, separating areas of food production from primary sites of consumption and encouraging the use of food preservatives to avoid excessive spoilage. Second, women continue to enter the work force in increasing numbers, creating a powerful demand for convenience foods in which food additives are common (Fennema, 1987).

Near Africa's mighty Niger River, farmers are anxiously waiting for rain to fall before they sow millet or sorghum, then hoe, harvest, feed their families and replenish their granaries. Meanwhile, researchers in Japanese, Chinese, Philippine, European and US laboratories are making studies in sequencing the 12 chromosomes and 50,000 genes composing rice, the matrix of all grains and a staple for three billion human beings. In five to ten years, they hope to know enough to genetically modify not only rice, but millet, sorghum, manioc and sugar cane as well. The aim is to make them "naturally" resistant to drought, soil salinity, viruses, blights and to other sources (Demenet, 2001).

In the forth of a series of articles on the Copenhagen Consensus project, we look at hunger and malnutrition. (…….) What can be done to address hunger directly? (……) The fourth course is to improve agricultural technology—for example, by using higher-yielding crops (which are often genetically modified) and controlling pests better. Many studies show high rates of return from such improvements, and the authors argue that these returns dwarf those from the other policies they consider.
("Feeding the hungry," 2004)

The above accounts exemplify arguments that are most often employed to construct the image of food processing technology as beneficial to society. According to those accounts, it is inevitable to "artificialize" natural food, if society intends to provide a continuous supply of foods to urban dwellers with limited access to local foods, working women and their family members, or the low-incomers. The arguments that have supported the so-called "Green Revolution" during 1940-70s (and now as well in underdeveloped regions) are clear: with only natural foods, we simply cannot feed them all. During 1940-70s, the primary purpose of agribiotechnology and food processing was to increase the quantity and availability of foods.

Clearly these arguments face difficulties in appealing to middle-to-high-income populations, who are willing to pay more or spend more time to consume natural whole foods. The notion that factory farm conditions or artificial food additives can engender "risks" for a large population has been widely recognized after the 1990s (Beck, 1992; Lupton, 1996; Valentine, 2002). And to boost such trends, "industrialized" organic food retailers are growing rapidly while they arguably meet consumers' demands for organic foods with low price and good accessibility—although the controversy over what counts as the genuine organic foods would remain (Allen & Kovach, 2000; DuPuis, 2000; Fitting, 2006; Goodman, 2000; Guthman, 2002, 2004; Jarosz, 2000; Raynolds, 2004).

Functional foods with their natural bioactive components came to the food market *after* the social concern over techno-industrialization of foods has become prevalent. The arguments supporting technoscience employed in functional food are clearly different from the ones supporting "risky" technoscience used in food industrialization. In other words, the technoscience in action here is supposed to be beneficial; not because it produces more foods for more people but because it *points out* healthy components in natural foods for us to consider. This technology is worthy our trust, whilst the old technoscience of mass-production/industrialization of foods is considered to be hazardous.

The notion that industrialization generates risks, whilst natural foods are trustworthy is observed in popular media accounts of functional foods. For example, an environmental activist, George Monbiot's article contributed to the *Guardian* summarizes the health benefits of omega-3 in fish. The author argues that "during the Paleolithic era, humans ate roughly the same amount of Omega 3 fatty acids as Omega 6s" but "today we eat 17 times as much Omega 6 as Omega 3" and that is compellingly associated with "dyslexia, ADHD, dyspraxia and other neurological problems" (Monbiot, 2006). According to him, we cannot have enough fish now because "fish are used to feed cattle, pigs, poultry and other fish - in the farms now proliferating all over the world." Another environmental activist, Michael Pollan's article in the *New York Times*, whre he argues that "industrial meat, raised on seeds rather than leaves, has fewer omega-3s and more omega-6s than preindustrial meat used to have" (Pollan, 2007). Because of their poor diets, the US population now intake significantly less omega-3 and suffer from "many of the chronic diseases associated with the Western diet, especially heart disease and diabetes." To put it simply, Pollan argues that "you are much better off eating whole fresh foods than processed food products" and offers scientific evidence for the argument. The above news articles contributed separately by two well-known environmental activists sum up the widely-accepted idea that health problems such as heart disease, diabetes and depression might be due to the industrialized condition of the Western society.

In October, 2006, the *New York Times* reported on a laboratory experiment performed by the Wisconsin National Primate Research Center with eye-catching images featured in Figure 3 (Mason, 2006). The news article showed the result of calorie restrictions experiments in rhesus monkeys. The monkey in the top picture of Figure 3, who is supposed to look younger and livelier, was on a low calorie diet, whilst the one below was on a high calorie diet. Interestingly, in the news article, low calorie diets are associated with the visual images of fermented soybeans, garlic, tofu and konyaku, whilst high calorie diets with the images of bacon, burgers, French fries and stakes. Although the experiment itself compared low and high calorie diets, the news article translated this information. The translation further strengthens the ideas that foods traditionally consumed in the East Asian countries are healthy while “McDonalidized” foods are not.

It is also marked in the mass media that “the Japanese eat a wide range of veggies, especially those in the cabbage family, including broccoli, cauliflower, cabbage, bok choy and kale [which] contain substances that may protect against cancer, whilst Americans’ most popular vegetables are French fries. Japanese have “antioxidant-rich green tea,” whilst Americans drink sodas (Helm, 2007). The majority of US population obtain carbohydrates through sugar and refined starches instead of from whole grains with “health-enhancing bran and germ and all their healthful nutrients, antioxidants and other disease-fighting plant chemicals” (Brody, 2003). Asian whole foods are natural and functional; whilst foods in the West tend to have insufficient amount of bioactive components, due to their heavy processing and mass-commodification. In the age of reflexive modernization, sensory organs of science in association with mass media seem to re-discover natural (or East-Asian) foods as an opposite pole against the risk of early modern society.

In September 2004, FDA announced qualified health claims for omega-3 for reducing the risk of coronary heart disease (Food and Drug Administration [FDA], 2004). Beck argued that risks of industrialized modernity which “escape perception and are localized in the sphere of physical and chemical formulas” (Beck, 1992, p. 21) are “managed politically and economically” (Beck, 1992, p. 19). FDA’s approval of omega-3 is not simply political and economic attempt to manage scientifically perceived health risks. FDA’s attempt to manage coronary heart disease will have to be based on (or “pass through,” to borrow Rose’s (2004) terms) molecular understanding of foods. In this sense, perceived risks of technoscience do not make society less dependent on technoscience. Rather, new scientific knowledge and technique come to work as a nexus through which political processes attempt to understand, intervene in and reform existing technoscientific risks.

The public's perception of the potential threat caused by Western industrialized diets exemplifies late modern conditions, where the perceived risk of technoscience becomes more problematic than anytime. Significantly lower amount of omega-3 or large amounts of trans-fats in Western diets are invisible to naked eyes. Yet such invisibility does not make people less concerned about health risks inflicted by industrialized foods. As Beck (1992) noted, such risks imperceptible to naked eyes are identified as serious hazards through the "sensory organs of science—theories, experiments, measuring instruments". In addition, through texts and images presented by the mass media the public becomes familiar with bioscientific sensory organs to interpret food-oriented health risks. In Pollan's article that criticized the contemporary meat industry, the health risks of industrially-produced foods are presented through bioscientific terms and knowledge—such as, what omega-3 or omega-6 are, which natural foods contain those bioactive components, and what their physiological effect is in human bodies. Through biomedical scientific findings, the mass media's performance, and the FDA's announcement, a connection is formed between omega-3 and people's perception of food industrialization as the source of modern risk (see Figure 4).

4. Governments Manage Risks of Lifestyle-related Diseases

After the mid 1980s and 1990s, many countries in North America, Latin America, Europe, and Asia went through budget cutbacks in health care whilst positioning health care policy within the neoliberal principles of privatization and decentralization (Cornia, 2001; Iriart, Elias-Merhy, & Waitzkin, 2001; McGregor, 2001; Terris, 1999). The budgetary cut goes hand-in-hand with the understanding that 1) the ageing population causes financial burdens and 2) most of the elderly diseases including diabetes, hypertension or dementia, are not curable to a satisfactory degree and 3) such chronic diseases needs to be *prevented* by healthy lifestyles (Bjornsdottir, 2002; Llyod-Sherlock, 2000; Sen & Koivusalo, 1998; Walker, 2000).

According to medical doctors' accounts on health care costs, "Preventable illness makes up approximately 70 percent of the burden of illness and the associated costs. [……] Lifetime medical costs, which average approximately $225,000 per person, are clearly linked to health habits. For example, the lifetime costs for smokers, despite their shorter lives, are higher than those for nonsmokers by approximately one third. [……] Multiple studies have demonstrated that providing medical consumers with information and guidelines about self-management can lower rates of use of services, often by 7 to 17 percent" (Fries et al., 1993, p. 322). What is notable in such arguments is the linear flow from the understanding that most expensive illnesses are preventable into the moralized thinking that *individuals* should be engaged in responsible self-management to make healthy society—in both physical and financial senses. Making oneself responsible for his/her own regulation and management becomes an ethical issue. In particular, it is argued that everyone have the ethical responsibility to become an *expert* in managing personal health (Beck-Gernsheim, 2000). The obligation that each individual should care for the self is articulated with the scientific understanding of chronic diseases and their financial burden to the national health care services; in other words, "individual" responsibility is no more located in the individual realm, but instead becomes enmeshed in institutional and organizational contexts (Sointu, 2005).

Onto such ideals of responsible individuals, governmental attempts to introduce functional food regulations are added as an efficient strategy to provide the official guideline of healthy lifestyles.

> Seven years ago [1995], the Japanese government changed the name of "elderly people's disease" to "lifestyle related diseases" for diseases such as diabetes, cardiovascular disease, hypertension and cancer. This means that these diseases are related not only to age but also lifestyle such as diet, nutrition and physical exercise. Scientific evidence on the physiological functions of food is increasing. To provide health information on foods to the people, the Ministry of Health and Welfare established a regulatory system for foods with health claims. Foods for Specified Health Use (FOSHU) was set up by the Ministry of Health and Welfare in 1991 to approve descriptions on a label regarding an effect of food on the human body (Shimizu, 2002, p. S94).[24]

Transformation of the relations between mankind and illness was once mediated by microbes, with the replacement of miasma and, according to Latour (1988), the realm of

[24] The author of the review article, Toshio Shimizu is a scientific adviser of ILSI Japan (International Life Science Institute in Japan). ILSI is a council of the Organization for Japan Supplement Adviser Authority. Shimizu is also a member of a committee for qualifying Nutrition Representatives in National Institute of Health and Nutrition, and a member of a committee of Nutrient Claim and Education of Japanese Society of Nutrition and Food Science.

transformation was not just Pasteur's laboratory but every street, farm, military in France and later in the whole world. That such a transformation accompanies social, material and academic dimensions is evident considering the increased influence of hygienists, vaccines and immunology on modern life. With the emerging notion of lifestyle-related diseases, scientific information on what foods are healthy, what molecular bioactive components do, the late-modern states' de-centralized status in welfare, and the idea that individuals should take care of their health strengthen one another.

Figure 5 shows texts and images from the United States Department of Agriculture (USDA) website. The website illustrates that governmental institutes' understanding of functional foods and their will to regulate lifestyle-related disease go hand in hand. The website introduces whole grains as healthier foods than refined grains and gives detailed dietary advice ("substitute the whole-grain for the refined grain, rather than add", "try brown rice stuffing in baked green peppers"). Whilst promoting several functional foods as a solution to lifestyle-related diseases, the department's interests in developing "quality" foods is noticeable. In one sense, this phenomenon is tied to the tendencies in agricultural policies which move away from high-yielding and intensive food production toward meeting consumers' demands for quality (Marsden, Munton, Ward, & Whatmore, 1996). Yet in addition to meeting consumers' demands, there is a growing assumption held by nation-states that "quality" in foods comes from health benefits of the foods' molecular components. In another sense, this goes along with the question of what food qualities and what type of health information are sanctioned. The above USDA website shows its attempt to be in tune with both bioscientific information and consumers with health concerns by performing the role of a translator. Bioscientific knowledge on functional foods and lifestyle-related diseases are translated by the USDA website into a form that consumers of the agricultural product can readily interpret—a form of dietary menu.

Consumers' demands to *know* more about healthy effects of molecular components in food, rather than to simply enjoy delicious foods, are receiving attention from scientists and the government. In a review article on the health benefits of functional foods, Roberfroid (2000, p. 1398S, emphasis added) notes that "although there are still many people who know little about nutrition, itself, *consumer awareness* of the subject [functional food] and its relation to health is growing appreciably." It is notable that his review article was presented at a symposium supported by educational grants from the National Institutes of Health Office of Dietary

Supplements and the US. Department of Agriculture. Governmental agencies and scientists alike are interested in promoting the *knowledge* that through constant management of everyday diets and habits, people can become healthier and as a result health care costs can decrease. Probably for a more vivid example of government aiming to structuralize everyday health management can be found in the UK. government's plan to build "fit towns".

> The government is planning to tackle the growing obesity epidemic in Britain by broadening its plans for eco towns and turning them into healthy or fit towns. (……) The health secretary, Alan Johnson (…..) wants Britain to follow the example of 10 French towns which have focused on young children and seen substantial cuts in obesity. The initiatives in France led to the proportion of overweight boys aged seven to 12 falling from 19% to 10% and in the girls from 10% to 7%. He is convinced only a comprehensive rather than the current fragmented approach will work. Practical measures in new healthy towns being considered by ministers include:
>
> · Regular weigh-ins for children starting as they leave primary school, including the recording of body mass indexes
> · Increasing the number of cycle lanes
> · Designing safe walking routes to schools and from suburbs into the centre
> · Programmes in schools to inspire children to eat healthily, avoid fast food outlets, learn to cook and play sport from a young age (Wintour, 2007).

Here we can see some connection between governments' interests in health care and biomedical knowledge. According to another newspaper article in *Daily Mail*, the Health Secretary Alan Johnson's proposal for transforming eco-towns into fit towns has been made hours after the World Cancer Research Fund (WCRF) reported their five-year study, "which found that one third of cancers are linked to diets or failure to exercise sufficiently" ("'Fit towns': Latest government plan to tackle Britain's rising obesity," 2007). Whilst the *Daily Mail* article summarized that the WCRF's biomedical report recommended "people cut out the amount of red meat in their diet and avoid completely processed meats such as bacon and ham," the article also emphasized that obesity "costs the country £1 billion a year and this bill is set to soar to £45 billion within 40 years."

Considering the ardent work of health institutes in establishing functional food regulations, relaying scientific information to the citizen, and constructing the space—be it territorial or on-line—for regulating lifestyle-related diseases, it seems reasonable to argue that neoliberal health policies focusing on primary health care by individuals do not necessarily mean "less government" but a different modality of health governance. It has been argued by many that the new technology of neoliberal governing is related to making of the neoliberal subject—the so-called "entrepreneur of self" (Ferguson & Gupta, 2002; Rose, 1996; Walkerdine, 2003). The government becomes no less engaged with understanding, translating and reproducing technoscientific knowledge products during its course of converting its citizen into experts of healthy lifestyles. "The active engineering of the space of innovation" and co-creation of "production, consumption, commodity, the market and indeed innovation" are new tendencies in capitalist commodification as Thrift argued (Thrift, 2006, p. 282). Such active engineering, production and distribution of bioscientific knowledge are also new tendencies in health institutes' strategies against perceived health risks.

5. Understanding and Reforming Natural Foods

So far I have argued that health benefits of whole grain and health risks of meat are framed by bioscientific terms and techniques focusing on molecular bioactive components. Through functional foods, the meaning of natural foods is re-constructed and comes to be associated with beta-glucan or omega-3. In addition, social processes such as food marketing, issue-raising, and governmental health-maintenance strategies are increasingly mediated by biotechnoscientific knowledge, language and practice for the molecular understanding of natural foods.

Understanding of natural foods is increasingly mediated by bioscientific knowledge and practices in molecular level or what Rose (2006, p. 108) have termed as the "molecular gaze".[25] Previous studies of the molecular gaze usually focused on the understanding of human bodies (Oudshoorn, 1994; Rose, 2003). For example, more psychiatrists tend to understand depression as a result of chemical imbalances in the brain (Rose, 2003). Functional foods reveal a case where the molecular gaze extends its realm from human bodies to an essential sustenance of human life—food. With this extension, new associations of humans (such as consumers and

[25] Similar to Rose, Kay (2000) also argued that the increasing interests in the DNA sequence resulted in "a molecular vision of life supplemented by an informational gaze" (p.16). This informational "gaze" involves according changes in materials, techniques and theories through which the readiness to recognize and solve problems at molecular/genetic level is strengthened.

functional food developers), nonhumans (such as salmon or newly developed bacterial strains) and ideas (such as bioscientific information and the hope to find a "natural" solution to health problems) are assembled.

In this section, I argue that molecular understanding of foods is connected to molecular transformation of foods; and the simultaneous understanding and transformation are blurring the boundary between natural and artificial foods. This argument follows Rabinow's (1992) concept of biosociality. By illustrating special interest groups' attempt to understand and simultaneously reform their genomic mutations, Rabinow argued that the object to be known cannot be separated from the social will to change the object. Such interconnectivity of the social will and technoscientific practices at molecular levels is also observed in functional foods.

> We have now exported our diet and diseases around the world. The modern Japanese diet contains an increasingly high proportion of fat, sugar and animal protein. As a result of globalisation and Western diet, young Japanese are much taller, stronger and fatter, but just as we have come to accept raw fish and the occasional allergy, they are having to overcome the menace of some cancers common in the West. (……) Those who want to reduce their chances of developing this cancer are well advised to take antioxidant vitamin-rich foods, keep the level of fat down, remain slim and take regular brisk exercise. There is evidence that selenium helps and, perhaps above all, they should be taking large helpings of cooked tomatoes and ketchup. Those who don't like the taste of tomatoes may prefer to take Lyc-O Mato capsules, which are an easy alternative (Stuttaford, 2003)

In the above news article published in the *Times*, we see that how promoting "less Westernized" diets goes along with spreading Western (which is almost universal at this point) biotechnoscience. Biomedical science works as a pointer and enables consumers to focus on the bioactive components—such as selenium—contained in natural foods. For instance, to "properly" compare the Western and Japanese diets, antioxidants in green tea and trans-fats in fried potatoes need to be compared. Whilst unprocessed, unrefined and "natural" diets are constructed as a solution to the perceived risks of the modern food industries, biomedical technoscience is simultaneously constructed as the provider of the undisputed evidence regarding the quality of natural foods. Seemingly, this informative and beneficial kind of biomedical technoscience is different from the "artificial" technoscience of food processing; yet they are not necessarily separated in actual practices. In the above article, support for natural functional foods and the one for "artificial" dietary supplements go together (It's great if you can eat tomatoes but you can also take capsules!).

The expanded role of biomedical technoscience from an information provider into an engineer is found often in the development of natural and artificial functional foods. For example, we see that biomedical technoscience works as an information provider when we read the newspaper article reporting that omega-3 in natural fish is associated with "low rates of murder and depression" of fish-eating Japanese people (Lawrence, 2006a, 2006b). That *information* is not separable from double blind *tests* devised by National Institute on Alcohol Abuse and Alcoholism (NIAAA) in NIH, which examined if purified capsules of omega-3, instead of fish-flavored corn oil, can reduce standard scales of hostility and irritability in aggressive alcoholic volunteers (NIH, 2001).[26] It is also the same biomedical knowledge that encourages the Food Standards Agency in UK to conduct "a systematic review of research looking at the effect of nutrition and diet on performance and behaviour of children in schools" before it may recommend that schoolchildren should be given fish oil supplements regularly (Smithers, 2003). Biomedical knowledge might start with observing; yet during the process through which "innovations are constantly trying to multiply themselves" (Thrift, 2006, p. 281), it makes previously unfamiliar actors, places and circumstances hang together. The health regulation, omega-3, behavioral anomalies and pigs comprise an exemplary set of unfamiliar actors.

Whilst expanding its realm, biotechnoscience also produces ambiguous types of functional foods of which "naturalness" or "artificiality" is not immediately apparent.

> Michelle Celona, a 43-year-old part-time teacher in Philadelphia, had suffered from annoying bouts of constipation. Figuring it was the stress of carting three children around or the result of something that had changed in her body after pregnancy, she learned to live with it. But when the Dannon Company asked Ms. Celona in June if she wanted to participate in a two-week trial for Activia, a new fortified yogurt that the company said could help speed up what nutritionists delicately refer to as intestinal transit time, she jumped at the chance. "I was skeptical that it would work," she said. "But if it's something I already like, then that's much better than popping a pill" (Warner, 2005).

Here again it is easily noted that the increased interests in functional foods are associated with the consumers avoidance of artificial technoscientific products—such as a pill. The

[26] The NIH discloses information on the clinical trial on its affiliated website, which is listed in the reference.

necessity to find "eating something I already like" as an alternative against "popping a pill" is increasing as "people (including the aging baby boomers) are getting nervous about pharmaceuticals" (Warner, 2005).

However, following the technoscience employed in developing this "natural" solution reveals that we cannot take the meaning of "natural" as an opposite end to "artificialial" anymore. Biotechnoscience involved in functional food development often acts more than as an eye to look at molecular components in natural whole foods. The yogurt product Activia is made by fermenting milk with an innovative bacteria strain, *Bifidobacterium animalis* DN 173 010—which is produced and patented by the Danone company. Whilst many other strains previously used to ferment milk could not survive during the passage through the gastrointestinal tract, *Bifidobacterium animalis* DN-173 010 "survived successfully (10^5-10^6 colony forming unit/g) for at least 90 minutes in the stomach" and gave more digestive health benefits to hosts (Activia, n.d.).

Although consumers perceive Activia is natural and is different from "pills," it has never been disclosed clearly if the Danone used plasmid transformation (which is considered to be genetic engineering) or classic bacterial mutagenesis (usually using ultraviolet ray irradiation) combined with generational screening to develop their special bacteria strain. On the other hand, the company emphasizes that *Bifidobacterium animalis* DN 173 010 passed the efficacy and safety study to be qualified as a "probiotic" functional food.[27] Activia has made $100 million in sales in the US in its first year with its scientifically-proven health benefits (Powell, 2007). It is not important if Activia is *really* a more natural food than a pill. The impact of advertisements that Activia is "a natural food, containing two bacteria used traditionally in yogurt, Streptococcus thermophilus and Lactobacillus bulgaricus, as well as a third, Bifidus Regularis™" and "is clinically proven to naturally help regulate your digestive system in two weeks when eaten daily" is already real in its consequence of blurred boundary between the natural and the artificial foods. In this case, biotechnoscientific practices, health-related knowledge and consumers' desires for health-maintenance through natural solutions are the key actors which make such a blurred boundary sustainable. The boundaries between food-processing, natural foods, and making pills are becoming increasingly porous as biotechnoscientific knowledge becomes widely available

[27] Probiotics are live microbial organisms thought to be healthy for the host organism. Food scientists generally include a probiotic enriched yogurt as an example of functional foods. See, for example, Jones and Jew (2007) and Powell (2007).

and relevant. Although some consumers might be purchasing Activia only because they are interested in natural *rather than* pharmaceutical solutions, it does not imply that the symbolic status of natural foods as an opposite of artificial foods will be maintained. Governmental regulations also aid the processes of reforming what natural food is supposed to be, the examples of which I will discuss later in this section.

In some cases, promoting "artificial" foods even becomes an explicit goal of functional food developments. Sjef Smeekens at the University of Utrecht sees that developing GM functional foods with "an undeniable medical reason" is regarded as "the only hope" for reducing "the anti-GMO feelings damaging to European plant biotechnology research" (Powell, 2007).[28] Similar arguments can be found in several accounts made by food-bio scientists.

> A new phase has started in the exploitation of GM crops in the creation of products with direct benefits for the consumer—including health-beneficial substances in foodstuffs (nutraceuticals and functional foods) and medicines. One example is the "golden rice" enriched with provitamin A, for which its manufacturer Syngenta will seek marketing opportunities in developed countries as a "healthy food" (Kleter et al., 2001).
>
> Major biotech companies are accused of producing "Frankenstein food," especially in Europe. They quickly caught onto the image-enhancing advantages of helping to develop GMOs for the Third World. In 2000, amid a blaze of publicity, biotech heavyweights granted the free use of 70 patents to help develop a genetically-modified variety of rice enhanced with beta carotene. The grain was heralded as a "miracle rice" capable of conquering Vitamin A deficiency, which kills one to two million children each year (Demenet, 2001).

Attempts of some biotech companies to promote GMOs through the ambiguous notion of functional foods have been criticized mostly by consumer-activists. For instance, Organic Consumers Association in the US has published an article "The Next Generation of Frankenfoods: So-Called 'Functional Foods'" on their website (Organic Consumers Association, n.d.). Corporate Watchdog in the UK published "The industry strikes back: functional foods, good for Monsanto's health" on the website in May 2000 (Corporate Watchdog, 2000). In the

[28] A similar argument was made for the omega-3 enriched pig, which is genetically modified. Kang and Leaf (2007, p. 505, emphasis added) argue that "as for consumer perception, the omega-3 pig is likely to be well received because unlike other genetically modified products, omega-3 animal products have additional nutritional value: a high concentration of *beneficial* omega-3."
For a case where the mass media article for non-academics reports the benefits of genetically-modified functional foods, see Thym (2004).

articles, functional foods are framed as just one of industrialized foods in global capitalist regime of foods (McMichael, 2000). Clearly, the modern projects of food industrialization and the global corporate interests do not disappear in the functional food network—and some activists along with scholars particularly emphasize that "industrial" aspect of functional foods (Sibbel, 2007).

However, even within the continuous processes of food industrialization, a new type of transformation is notable if we look at functional foods discussed so far. Through the notion of functional foods, both natural foods and artificial foods are connected to "health benefits" and "images of nature". Subsequently, consumers of functional foods come to *compare* natural and artificial foods on *the common standard* instead of understanding the two as incompatible categories. This does not imply that people do not differentiate natural and artificial foods any more. An individual consumer might regard genetically modified rice with enriched vitamin A as clearly artificial and yogurt with modified bacteria as clearly "more natural than a pill." Yet this boundary between golden rice and Danone yogurt is neither pre-determined nor commonly accepted; the boundary between natural and artificial foods is being constructed and negotiated depending on particular processes of food development, marketing and consumption.

The remaking of the natural/artificial boundary is also aided by food-related regulations administered by health-related governmental institutes. According to the FDA regulation, certain bioactive components added to natural foods as a result of genetic modification can be "exempt" from the status of "food additives" if the bioactive components qualify as "generally recognized as safe (GRAS)". Hypothetically, if the Food and Drug Administration, the Federation of American Societies for Experimental Biology (FASEB) and the Flavor and Extract Manufacturers' Association (FEMA) determine the "GRAS" status of quercetin and kaempferol (which have anti-oxidant properties and health benefits) in genetically modified tomatoes developed by the company BASF Plant Science, then the quercetin and kaempferol in GM tomatoes are not subject to regulation as "food additives." Even though the amounts of two antioxidant molecules are increased through genetic modification, it is possible that they are exempt from the usual Federal Food, Drug, and Cosmetic Act (FFDCA) food additive tolerance requirements.

The distinction between GM and GRAS indicates that governmental regulations can transform artificial foods into natural foods. Even genetically engineered foods can be regarded as food-additive free if the safety of bioactive components increased in genetically engineered food is scientifically demonstrated. A new assemblage is formed around GRAS additives, which includes bioscientific expertise working on food safety, the market's unyielding interests in developing genetically modified foods, consumers interested in natural foods and the governmental regulations reconstructing the boundary between natural and artificial foods. By selectively allow only certain bioactive components to become "GRAS" instead of food additives produced by genetic modification, governmental agencies stand between the food industry's attempt to promote genetically modified foods and consumers' turn to natural foods.

Lycopene capsules, omega-3 capsules, Danone Activa, and GRAS illustrate that molecular bioactive components in natural foods, the new object to be known in health risk society is closely associated with the social will to produce artificial foods. The heterogeneous categories that functional foods involve—inherently healthy, fortified, and designed—thus reflect not just the term's ill-defined status but also the continuous re-constructing of the boundary between nature and artificiality. As interests in healthy foods are channeled through molecular bioactive components in natural foods, consumers do not simply return to nature. Rather diverse social groups and material/institutional resources are grouped around natural foods and their bioactive components. This biosociality of foods constructs a more complicated mixture of natural and artificial foods, foods and medicine, and understanding and reform.

So far I have demonstrated that functional foods provide a setting where society's growing interest in natural foods leads to the blurred boundary between natural and artificial foods. Around functional foods, food scientists' research on molecular nutrients, governmental health institutes' attempt to regulate lifestyle-related diseases and food safety, and the food industry's attempt to promote GMO through health benefits are connected to each other. Explicitly heterogeneous categories of functional foods reflect the condition where the blurred boundary between natural and artificial foods cannot be sufficiently explained as the politico-economic conflicts between genuine counter-cuisine and the veiled projects of the food industry to conventionalize it. Functional food is a product of biotechnoscience that proves its health claims, whilst it is also a product of late modernity where more people are interested in the health benefits of "natural" foods rather than in the productivity of industrialized foods In this sense, natural-ness in functional food is not *supposed to be* purified. Instead, functional foods perform as a site where nature can be intervened by scientific knowledge, corporate interests, the perceived risks of modern industry and governmental food-health regulations tuned to individual management.

6. Summary

Certainly, functional food is not the first, or the only kind, of foods perceived as healthy foods in society. Yet in this chapter, I argued that functional food is a new phenomenon in a sense that it cannot be summarized as simply another form of natural, industrialized or healthy foods. A growing number of research practices in food/biomedical science, regulation policies, and clinical treatments are affected by new knowledge focusing on molecular bioactive components in foods. Simultaneously, mass media accounts have come to articulate and distribute *molecularized* notions of foods (though not necessarily with celebrating tones). Furthermore, food scientists and regulators contend that consumers *should* be provided with more bioscientific information necessary to make *informed decisions* on specific foods and their associated components to reduce health risks. Consumers' tendencies to pursue specific health benefits beyond basic nutrition through food are hardly anecdotal. In this chapter, I present several examples of functional foods which are produced through the action of individual health concerns, biotechnoscience, and institutional strategies for health regulations. By so doing, I analyzed functional foods as a place where technoscience understanding, food industry and social initiatives for individual health regulation all attempt to be connected closely to "natural" foods, and in their actions fundamentally transforms the meaning of "natural".

In a 1998 International Food Information Council survey of 1,000 consumers, 95% expressed their general belief that certain foods could *reduce disease risk* or improve health. The 1999 Prevention/Food Marketing Institute (FMI) survey found that 57% of consumers were involved in *dietary prevention of disease*, up from 51% in 1998 (Hasler, 2000). Overall, the new food category of functional foods "[which] *are demonstrated to reduce the risk of chronic disease beyond basic nutritional functions*" has become a conspicuous nexus to connect new language, scientific research, and everyday behaviors in a post-1990's society (Health Canada, 1998). If an increasing anxiety about health risks defined by multiple organizations is the general condition of late modernity, as Lupton (1993) argues, my empirical analyses on functional foods reveal the previously unexamined processes which construct a new risk-management network. In the network, scientific practices, molecular information, chronic diseases, everyday foods, and consumers' cultures interactively stabilize each other.

CHAPTER 3
MOLECULAR THOUGHT STYLE

1. Introduction

(1) Outline. In Chapter 2, I gave several examples of functional foods in order to illustrate two emerging frames of understandings: that functional foods can reduce the risks of chronic or “lifestyle-related” diseases and that chronic diseases are perceived as a result of unhealthy habits and environmental risks prevailing in industrialize society. I demonstrated that the emergence of functional foods include the valorization of natural, less-processed and Asian foods through their molecular bioactive components. In the selected cases of functional foods, they seem to connect the public’s fear of modern industrial risks, food industry’s attempt to repackage some processed foods, government approaches to control chronic diseases, and finally molecularized ways of observation, documentation and transformation of nature. The connections constructed through functional foods could be noted as a material-social-cultural assemblage—in a sense that bioactive molecules, foods, moral consciousness (that individuals should become responsible for their own health), and a marketing strategy of food industries all hang together (Pickering, 1995, 2005b).

In this and the following chapter, I will examine a particular kind of functional food developed in Korea in an attempt to make a more detailed analysis of how such complicated connections are constructed. The main object of my multi-sited ethnographic research is germinated brown rice (later indicated as GBR or “bal-a-hyeon-mi” in Korean). Accounts on its health benefits and molecular bioactive components appear in many published scientific articles and mass media accounts. Some brief examples are presented below.

> Chronic ethanol abuse can cause liver damage and unfavorable lipid profiles in humans and rodents. (……) In this study, a germinated brown rice grown under conditions that favor high concentrations of gamma-aminobutyric acid (GABA) was evaluated for protective effects against the toxic consequences of chronic ethanol use. (……) brown rice extracts containing a high level of GABA may have a nutraceutical role in the recovery from and prevention of chronic alcohol–related diseases (Oh, Soh, & Cha, 2003, p. 115).

The above quote is from a scientific research article published by a Korean food scientist, Oh Seok-heung. Oh and his colleagues at Woosuk university in Korea published several articles on GABA, GBR and some other GABA-enriched functional foods. Some of their research, including the microbiological techniques to increase GABA in Korean traditional fermented foods, led to Korean patents. GABA is a major neurotransmitter in animal brains, which was discovered in 1950 separately by two neurobiologists, Eugene Roberts and Jorge Awapara.[29] Since then, GABA has been widely recognized as one of the essential neurotransmitters in the fields of neuroscience and pharmacology.[30] It came to gain the name "the brain's natural tranquilizer" since its first reported symptoms of depletion included epilepsy and anxiety disorders. Like many other neurotransmitters, the list of GABA-depletion symptoms expanded through time. Now the symptoms resulting from the lack of "the brain's natural tranquilizer" include insomnia, muscle stiffness and obesity.[31] Accordingly, various GABA-based pharmaceutical drugs have been developed and marketed—for example, valium, ambien, neurontin, pregabalin and topiramate.

The above quote from Oh's research article exemplifies a common pattern of GBR research documented by food scientists. Here functional foods or rice are juxtaposed with their molecular bioactive components (GABA) and their health benefits for chronic, lifestyle-related diseases such as chronic alcohol-related liver damage.[32] Later in the research article, chronic alcohol-related damages in liver are more specifically defined as the increase in LDL-cholesterol (also known as bad cholesterol) and triacylglyceride (also know as neutral fat) in laboratory animals that were chronically fed with alcohol. The health benefits of GBR and/or GABA were measured in terms of their effects in decreasing LDL-cholesterol and triacylglycerides.

Do you starve to lose weight? I eat rice for my diet!

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[29] For explanation on GABA as a neurotransmitter, see any major textbooks in neuroscience—for example, Bear, Connors, & Paradiso (2001, pp. 145-46).

[30] During 1930s-50s, one mainstream of neuroscience was neural electrophysiology using EEG; and neuropharmacology was another. Amphetamine drugs ("speed") were introduced for the first time to treat narcolepsy was in 1935. LSD was first synthesized in 1938. And in 1946, a Swedish biologist Ulf von Euler isolated noradrenalin, a neurotransmitter existing in the brain of which release is stimulated by amphetamines. Discovery of noradrenalin was one of the founding studies that moved the interest of neuropharmacology from injecting exogenous drugs to isolating endogenous neurochemicals and binders to neuronal receptors (called as ligands). The isolation of GABA followed this flow of interest.

[31] Differences in GABA depletion symptoms depend on many heterogeneous factors, mainly different brain regions where depletion occurs.

[32] Saikusa, Horino, and Mori's (1994) research article is generally regarded as the first scientific research article on GABA in GBR. The article reported that GABA increased when brown rice is soaked in 40 degrees in Celsius water for 8 hours to 24 hours.

> Rice is good for health. In particular, if you germinate brown rice, the level of gamma aminobutyric acid, often called GABA increases in brown rice. It is reported that rats with high blood pressure showed a marked decrease in their blood pressure after eating GABA-increased rice (Ha, 2006).

The above news article and the picture in Figure 6 are from a Korean major newspaper, *Chosun-Ilbo*. The title "Neon Gul-Meo Ppae-ni? Nan Bab Meok-eo Ppaen-da! [Do you starve to lose weight? I eat rice to lose weight!]" and the picture of a thin woman in front of a rice bowl represent the media's translation of lowered cholesterol in lab animals correlated with their intake of GABA-enriched GBR. In short, GBR meets the definition of functional foods employed in this dissertation—any kind of food product that can prove its efficacy or functionality through designated clinical trials. GABA is a bioactive molecule contained in brown rice, of which amount increases after sprouting.

This chapter consists of three main parts. I begin by describing Korean historical and cultural environments in which functional "rice" comes to be perceived as a natural, scientific and healthy product. Here I employ policy reports written by technical experts in governmental health/food/agriculture agencies and media articles to give accounts on the contexts of GBR development. I use these materials not because they testify the "real" contexts of functional rice development. Instead, those texts are addressed as the sites to observe and analyze how diverse actors construct the perceived importance of functional foods and bioactive molecules whist making regular contacts with scientific terms and practices.[33] In particular, in this chapter I focus on the practices of scientists and journalists to construct GBR as a functional food and GABA as a bioactive component in this chapter (in chapter 5, the practices of consumers will be analyzed in relation to on-line communication). The second section of this chapter will focus on analyzing the *interaction* between scientific and popularized accounts in terms of how they construct the network of GBR, GABA and health benefits for chronic diseases. In so doing, I problematize

[33] For the use of texts in academic journals and the mass media articles to analyze contexts of scientific knowledge construction, see Treichler (1999). In addressing the relation between language and scientific knowledge, Treichler argued that the very nature of scientific object is constructed through linguistic management of ambiguity and uncertainty. In this sense, one cannot determine what the reality is by looking only scientific "facts" separated from the cultural dimension such as the media texts. According to Treichler (1999, p. 15), "Our social construction of AIDS are based not on objective, scientifically determined 'reality' but on what we are told about this reality." I analyze the texts in peer-reviewed journals and the mass media in an attempt to examine how functional foods and lifestyle-related diseases are constructed based on what we are told about them.

popular assumption that scientists produce the original truths whilst the media distort scientific information through simplification (Hligartner, 1990). Finally, in the third section, I illustrate disagreements between the US and Korea regarding the (accepted) bioactivity of GABA. By analyzing how disagreements are maintained without controversies, I emphasize that functional food as a knowledge product is constructed through the *collective* action of popular and esoteric science.

(2) Research materials. This chapter aims to answer to the question of how some scientists and journalists performed in an interactive way to transform brown rice from lower-grade rice into a functional food. Research materials were obtained from food science peer-reviewed publication, interviews of some authors and newspapers covering the health-benefits of GBR and/or GABA. Food scientists' research articles, news articles and advertisements containing the information about GBR and GABA were found by using PubMed database and Korean news portal sites. I have read thirteen research articles on GBR published in peer-reviewed journals (excluding reviews, forum presentations or news articles) and interviewed some of the authors and their collaborators. The excerpts used in this chapter were selected as representative findings of most research articles that I have read. All of the research articles were published by Korean or Japanese scientists working in universities, research institutes and in food companies.

All of the research articles that I examined analyzed health-benefis of GBR (such as Alzheimer-ameliorating, fat lowering, hypocholesterolemic, cancer cell apoptosis and hypotensive), whilst mentioning Gamma Aminobutyric Acid (GABA) as one of the most important bioactive components in GBR (Mamiya & Ukai, 2004; Miura et al., 2006; Oh et al., 2003; Oh & Oh, 2004; Oh, Choi, Lee, & Song, 2005; Kang, Kim, Koh, & Nam, 2004; Lee, Kim, Kang, & Nam, 2007). The role of GABA as a major neurotransmitter in human brains has been studied since 1950 in the field of neuroscience and pharmacology. The known health benefits of GABA and/or GBR include lowering the level of bad cholesterol, enhancing memory, and reliving anxiety. In 1994, Mori in Chugoku National Agricultural Institute in Japan published a research article demonstrating that GABA in rice germ is increased after soaking in the water. Since then, many research articles have regarded GABA as one of the main bioactive molecules in rice--especially dehulled brown rice with its remaining germ.

So far, Japanese and Korean scientists in universities have played the key role in publishing research articles on GBR and GABA. Occasionally, scientists in research institutes affiliated in food companies collaborate. Some food scientists in universities are directly or indirectly involved in food-biotech companies with patented technologies to enhance GABA further in rice. GABA-enriched rice, which includes pre-germinated and packaged brown rice, brown rice germinated at home, chemically and genetically manipulated rice with a large amount of GABA, is available on the functional food market in Japan, Korea and China.

Many newspaper articles reporting health benefits of GBR and GABA were found in the Korean on-line and off-line media sources. They were used for analyzing the role of popular science in constructing a functional food network. It is commonly observed that the press releases closely juxtapose GBR, the food with GABA, the bioactive molecule. Also commonly observed in the media is the juxtaposition of GBR with health risks of lifestyle-related diseases. I first focus on the common tendency to emphasize that the information produced by food scientists and the media produce is more than scientific information on bioactive molecules or functional foods itself. As I will demonstrate further in the second and third part of this chapter, the *readiness* to see foods through their molecular bioactive components and to conceive functional foods as everyday habits that can prevent chronic diseases (such as obesity) are being produced both inside and outside of scientific laboratories.

Although I did not choose the media accounts that clearly offer incorrect scientific information to the readers, some of the media excerpts that I employ might look too simple or even incorrect from some food scientists' perspectives. Yet this does not diminish the quality of my research, since my research question is not how the media *should* summarize scientific knowledge to meet the implicit standards of scientific experts. The analytical focus of this chapter is what popular scientific accounts do in practice as new scientific knowledge and technological products emerge. The performance of popularized scientific knowledge will be observed and analyzed in relation to functional foods, molecular bioactive components and lifestyle-related diseases, the meanings of which are constructed by the collective action of food scientists and the media. Thus, this chapter does not question if the media summarizes scientific information correctly or incorrectly; it rather investigates how food scientists and the media construct points of contacts and how from such points the tendencies to develop functional foods are expanded.

2. Previous Literature: Thought Styles

It is commonly believed that the mass media accounts simplify and even distort scientific truths, as journalists do not have scientific expertise and/or interests in the academic contexts of scientific information (Nelkin, 1987, 1996). Evidently science sections in newspapers and academic journals do not provide the same level of scientific information to the readers. However, a two-stage model of scientists developing scientific knowledge and journalists as outsiders popularizing truths oversimplifies what "popularization" does in diverse contexts of scientific knowledge production. To reach broader audiences, to format their scientific results for publication, and to collaborate with people from different scientific fields, scientific experts participate in producing popular scientific knowledge (Star, 1983; Hilgartner, 1990).

Studies have shown that popularization is also a part of scientific process. Hilgartner (1990) gives an example of a review article in the *Journal of the National Cancer Institute*—"The Causes of Cancer: Quantitative Estimates of Avoidable Risks of Cancer in the United States Today" by the British epidemiologists Sir Richard Doll and Richard Peto in 1981—which was written originally for interested non-specialists with interests in cancer epidemiology. Yet in addition to its intended audiences, scientists in adjacent fields also used the review article, read how it synthesized previous literature on the causes of cancer, and cited it as a reference. Hilgartner shows that several research articles written by scientific experts treated the numbers as a solid fact, even though Doll and Peto, the authors of the review cautioned that their estimated percentages of cancer caused by various risk factors have limitations and could not be used for direct comparison. Numbers originally reported in ranges were also transformed into point numbers in an article published by National Cancer Institute. What Hilgartner criticizes here is not simply that scientists, as well as journalists, also participate in the production of simplified information. Rather Hilgartner aimed to answer to the question: for what purpose is the so-called "culturally-dominant view of popularization" which (erroneously) assumes the binary roles of scientists and popularizers maintained? According to Hilgartner, the view is not maintained because it correctly describes the relationship between popularization and genuine scientific knowledge production. Instead, there is political usage in the popular notion that scientific knowledge is distorted as it is popularized. When scientific experts implicitly or explicitly invoke the notion of uncertain science vs. simplified media accounts, the notion can strengthen the epistemic hierarchy of scientists over the lay public or outsiders of science.

Fleck (1979) also examined the role of popular knowledge in the process of scientific knowledge production. The history of developing the Wasserman test was described by Fleck in relation to a kind of "popular" knowledge or "exoteric" knowledge. The lock-and-key symbol is an example of popular scientific knowledge, which provided a vivid image of a specific antigen-antibody reaction to many serologists including Wassermann. With the faith in the idealized form of knowledge, which states that "the typhus antibody can produce immunity reactions *only with* typhus bacteria and the cholera antibody *only with* cholera vibriones", Wassermann and colleagues initially reported that they detected "a *specific* reaction between syphilitic antigen and syphilitic antibodies" from complement-fixation experiments (Fleck, 1979, p. 71, emphasis added). However, the antigens causing hemolysis in their experiments were not syphilis-specific, which means that Wassermann and co-workers' conclusion was totally mistaken. Still, from their initial experiments, the Wassermann test was developed and used widely to detect syphilitic blood. Fleck argues that the test which later entailed significant social changes as the detection method of syphilis was *not* developed out of random chance. Instead, Fleck sees that it was Wassermann's readiness to look for a specific reaction between a spirochete antigen and a spirochete antibody that enabled the development of the Wassermann test. While streamlined knowledge such as "the law of antibody specificity does not apply, of course, in the extreme form [and has] its limitations" (Fleck, 1979, p. 58), it was such a vivid image of the lock-and-key that constituted the further progresses in serology.[34]

Notably, the immunological reaction that Wassermann observed with the alcohol extract was named as the "passive" part of knowledge production by Fleck. It is a passive part in a sense that Wassermann could not know in advance what kinds of results alcohol would give. On the other hand, a *readiness* to perceive the complement-fixation as the result of a specific interaction between syphilis antigen and antibodies was noted as the "active" part of knowledge production. Fleck does not see the two different components of knowledge construction as objective observation vs. subjective interpretation. According to Fleck, goals, assumptions and dispositions that *direct* researchers to a particular choice among all the ambiguous results are not "subjective"

[34] Fleck also added that the lipoid theory employed in the development of the Wassermann reaction is based on a popularized chemical notion of the lipoid bodies, whilst the popular concept is quite different from the specialized chemical concept.

but "active" components. Importantly, Fleck sees that the special readiness for directed perception is constructed by the collective action of core experts and generally educated amateurs, or *esoteric* and *exoteric* circles as seen in the example of the serologists developing the new diagnostic method and the lock-and-key model in textbooks. Esoteric and exoteric circles, from Fleck's perspectives, comprise a "thought collective." And the vivid image, which originate in popularized scientific knowledge, "prevails over the specific proofs and often returns to the experts" in esoteric circles to influence their thought styles (Fleck, 1979, p. 117).

Hilgartner's and Fleck's studies complement each other in analyzing the role of popularization in the scientific process. Hilgartner's study did not focus on the role of simplified knowledge itself but on the political implication of the boundary work that maintain the ambiguous borderline between "genuine" and "simplified" knowledge (Gieryn, 1983). Fleck, on the other hand, revealed that simplification itself has a fundamental role in scientific knowledge production. According to Fleck, scientific fact is not derived spontaneously by experimental results alone. Rather, the readiness for directed perception, or the "thought style" is crucial in converting results into a solid fact (Fleck, 1979, pp. 109-110). In the construction of a thought style, the core experts are influenced by the vivid image mainly created by popularizers in exoteric circles. The limitation of Fleck's study, however, lies in the limited sources of his empirical observation of "popular knowledge." The exoteric knowledge used as an example comes from specialized experts' historical accounts or textbooks, which are still very close to esoteric circles. On the contrary, Hilgartner's examples of simplified accounts cover a wide range of scientific communication, including science-based agencies' reports, literature reviews and news releases.

In an attempt to combine the strength of Fleck's and Hilgartner's studies, the focus of this chapter is in analyzing how the popularization affects the construction of functional foods as new technoscientific knowledge products. The performance of popularized scientific knowledge will be observed and analyzed in relation to functional foods and molecular bioactive components, meanings of which are constructed by the collective action of food scientists and popularizer. In particular, I focus on the popularization by newspaper articles and advertisements as they act as distinct conduits of popular science. Unlike textbooks or literature reviews, newspaper articles and advertisement aim to address to non-scientific audiences and thus produce most "popular" images of science for the lay public. Influenced by Hilgartner's work, several studies have focused on the question of how public representation of science by the popular media strengthens the ambiguous boundary between genuinely scientific knowledge and popularized knowledge—and, by so doing, how it sustains the place of genuine science at the top of an epistemological hierarchy (Zehr, 2000; Mellor, 2003). However, how vivid images and core scientists' practices interact in terms of constructing a specific thought style has not been analyzed sufficiently with empirical data obtained from the popular media sources. This chapter, whilst explicating the processes of functional food construction, provides empirical details for analyzing the interaction between esoteric and exoteric circles during the production of new scientific knowledge on foods and human health.

A thought collective for scientific knowledge production, as Fleck notes, is rooted in a specific historical and social situation (Fleck, 1979; Clarke et al., 2003; Lowe, 2004). Syphilis was considered to be a "carnal scourge" resulting from pathological blood in the thought style of the medieval times; it was only since the 20th century that syphilis has been conceived to be caused by a microorganism (*Spirochaeta pallida*), against which the body produces immunological reactions between antigens and antibodies. The thought style for functional foods, or the readiness to perceive rice through molecular information, is also situated in the unique historical period of Korea—namely, the post late-1990s. Although this dissertation does not aim to provide a comprehensive history of the relationship between food science and Korean society, it should be noted that a readiness to focus on molecular bioactive components is a historically situated phenomenon. To reveal how the particular thought style around molecular bioactive components is situated in the post late-1990s in Korea and how that time period is differentiated from the past, I begin this chapter with a brief historical overview of the rice development in Korea during the late 70s.

3. The Korean Historical and Cultural Context of Functional Rice Development

Korea is an ideal site to observe emerging interests in functional foods. According to a report by Korean Health Industry Development Institute (KHIDI), the domestic market size of functional foods in Korea has reached around 2,100 billion won (about $2,100 million) in 2005 (Korean Health Industry Development Institute, 2007). Even though this number includes the sales of dietary supplements, the volume of functional food market in Korea is remarkable.

Statements that Korean government *should* boost scientific research on functional food and cultivate the related health industry can be found in governmental reports and in the mass media without difficulty. The following excerpts are from a report written by KFDA (Korean Food and Drug Administration) and an article in a local newspaper, *Daejeon Ilbo*.

> Recently, the pathological structure of the Korean population is moving its center from epidemics to chronic diseases. As lifestyles are addressed particularly as the problem among the several factors [of chronic diseases], chronic diseases are also called lifestyle-related diseases.
> Improving dietary habits will enhance the national economy, people's health and the quality of life by reducing the risk of lifestyle-related diseases. As modern [Korean] people have *dietary habits of advanced countries*, over-nutrition, environmental pollution and lack of physical exercises become important social problems. In addition to this necessity to be highly interested in foods, *scientific evidence that supports the healthy actions of certain foods* has continuously been found. The newly legal notion, "functional foods" was established in 2003 on the interests and support of the related industry (Im, 2004, p. 17).[35]

> "Although the [Korean] Government has invested billions in agriculture, there is no sign for agriculture to revive. I think that applying biotechnology to agricultural industry is the way to solve the problem." Bok Seong-hae (Chair Professor in Department of Pharmaceutical Engineering in Geon-yang University) thinks that the application of cutting-edgy biotechnology to agriculture can increase the market competence of [Korean] agriculture. Professor Bok says, "After the ratification of FTA, extremely cheap foreign agricultural products were imported. It is not an exaggeration to describe the situation of our agriculture to be hopeless." Bok argues that to solve the problem for the [Korean] descendents' fare and well-being, innovative strategies are necessary. For examples, he argues that Korean vegetables and fruits have many strong antioxidants with excellent bioactivity in anti-obesity and preventing hypercholesterolemia. [……] "We should expand agricultural and livestock sectors more and combine it with food-biotechnology for anti-obesity. By so doing we can create well-being industry." Bok explains that "persimmon leaves, buckwheat, ginseng, mandarin oranges which can prevent obesity and hypercholesterolemia" are readily obtainable in Korea and commercializing those [natural foods and/or their bioactive components] is not difficult ("Nongchuksaneob cheomdansaengmyeonggonghakgisul jeobmok [Hybridizing agro-livestock industry and cutting-edge life-science]," 2005).

The view shared by Im in KFDA and Bok at Keonyang University is that Korean functional foods can produce a large agro-food market and meet consumers' demands for healthy lifestyles. According to Im and Bok, "scientific evidence that supports the healthy actions of certain foods has continuously been found" and thus developing commercial products out of

[35] The author, Im, Ki-Seob is a regulatory official in Korean Food and Drug Administration (KFDA).

natural foods with bioactive components "is not difficult." In other words, scientific evidence supporting the health benefits of some natural foods are noted as resources that can be readily hooked to the interests of Korean agricultural sectors and health-conscious consumers.

However, it was not until the 1990s that scientific findings on bioactive components could be connected to $2100 million market, KFDA and the expectation for the burgeoning well-being industry competing in the neoliberal agro-food market.[36] Above all, Korean media was not always interested in reporting molecular information of foods. The main focus of Korean media in reporting news related to agro-food science had been, for a long time, on the increased productivity of crops—in particular, of rice.

Korea is known for its rapid economic development during the 1970s and the 80s. It is less often remarked that Korea is also a country where the "Green Revolution" made its impact most clearly in a relatively short period. Food shortage did not just occur during the Korean War in 1950. The production of rice, the main staple in Korea (as well as in other East Asian countries), fell short of demand even in the early 70s.[37] Even in 2000, media articles sometimes bring back the collective memory of rice shortage through the use of some memorable incidents.

> School teachers examined each student's lunch box and scolded pupils who brought white rice. In [19]71, restaurants were prohibited from selling white rice on every Wednesday and Saturday (Cho, 2000).

Mixed-grain encouragement policy was driven by the strong developmental government. The use of cheaper grain such as barley or millet was highly recommended. In particular, according to the biography of President Park Chung Hee, the use of less hulled brown rice was encouraged explicitly by Park.

> It is heartbreaking to see that many people do not cooperate with the [governmental] encouragement for the consumption of brown rice. Hulling 90% of the rice bran is not necessary and in my view 70% is enough. In Cheong-wa-dae [the official residence of the Korean president], we have been eating brown rice since last year. The government does not encourage things that will cause health problems, malnutrition or diseases. Eating brown rice is better for health, can decrease the demand for foods [including high quality

[36] After the Uruguay Round Agreement on Agriculture in 1993, Korea opened its agricultural market. The globalization of Korean agricultural market took further steps with the establishment of World Trading Organization (WTO) in 1995 and Doha Development Agenda in 2001.

[37] Yet in 1991, 2.14 million ton of rice was left over after consumption (Park, 2005).

grains], and thus saves our expenditure of foreign currency (Joongang Ilbo team for special reports, 1998).

Yet a remarkable increase in rice production in Korea was made during the late 1970s. South Korean government declared its self-sufficiency in rice "for the first time in fifty centuries of Korean history" in 1975 (Kim, 2007; Kim and Summer, 1968). The main cause of this dramatic change is attributed to a crop variation named "IR667."

IR667 was developed in 1967 by a Korean agricultural scientist, Heu Mun Hue while he was in the research training program at the International Rice Research Institute (IRRI) in Philippines, founded jointly by the Ford and the Rockefeller foundations in 1961. As a global research center for the Green Revolution project aiming to increase the agricultural productivity in the third world, IRRI sponsored research on developing high-yielding variety (HYV) rice, which included Heu's research on "triangular hybridization" technology and IR667 (Kim, 2007). In 1971, the Korean Rural Development Administration (RDA) succeeded in growing IR667 in Korea. Later, IR667 came to be named as "Tong-il (meaning reunification in Korean)" rice and was promoted widely to increase national rice production by the Korean government. The domination of Tong-il in Korean rural towns occurred quickly. Within two or three years 300,000 ha of land in Korea were used for growing Tong-il rice. Although Tong-il was known for its unappetizingly dry taste (Koreans traditionally favor sticky and glutinous rice), it could not stop the Korean government's strong will to achieve self-sufficiency in rice.

The story of Tong-il rice reveals a coupling of technoscience and the developmental state's will for self-sufficiency. Of course, the agenda of "producing more foods" was not something exclusive to Korea. According to William Gaud who first used the phrase "green revolution" in a speech to the meeting of the Society for International Development, the green revolution refers to "more intensive, more productive" agriculture aided by high-yielding seeds, fertilizer, pesticides (Goud, 1968). Within this network, the application of technoscience to natural foods was supported by the argument that food technology can make more food available to the poor in developing countries. Overcoming malnutrition through the green revolution was on the global agenda during the 1960s and 70s. Development of Tong-il is one case that the green revolution was strongly supported by a nation-sate.

The subsequent decline of Tong-il production coincides with the socio-economic transformation that Korea has undergone, from an underdeveloped state to a consumer society.

Even when Korea's economic growth slowed down in the early 90s, consumerism still expanded rapidly (Cho, 2002). With its economic growth, Korea achieved sophisticated consumers with little interests in the state's agenda of rice self-sufficiency.

Tied into this socio-economic transition is a transformation of agro-food scientists conducting scientific research for rice development. Professor Kang, an agro-food scientist who was involved both in developing Tong-il rice and GABA-enriched functional rice recalled the rather abrupt transition in Korean agricultural science.[38]

> I have worked on food/agriculture science for about 15 or 16 years. I have seen so many changes. When I first started research, agro-food laboratories in universities could maintain their characters. We could just aim to increase agricultural productivity. After 90s, it changed a lot. What we call as the most important research agenda… changes over time (……). We had rice blast in 1979 and cold winter in 1980. And since President Chun Doo Hwan did not want any more political turmoil [after the assassination of President Park Chung-Hee, who was a developmental dictator], he imported extravagant amount of rice. It was more than 1.5 times that all the Korean population needed. And with rice left without being consumed, the government stopped supporting agrofood research focusing on productivity. No one can get funding for further research on productivity now. Though I still think we should work further on hybridizing [high-yield] Tong-il rice and glutinous Japonica rice to make both tasty and productive rice, [the amount of research done on Tong-il has declined significantly along with the decrease in governmental support]. (……)
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> After Tong-il's declination in the late 80s I thought of doing research on tastes [of rice] but the standard of taste is so ambiguous. I thought I might not get funding with the research proposal on delicious rice. To us, funding is very important. So I thought about how I will continue agro-food research. Then I came to turn my interests to functional foods, made some mutants, and one of the agricultural mutants had a bioactive component [referring to GABA] that can improve lipid metabolism… diabetes… cholesterol contents (J. Kang, personal communication, January 20, 2008).

The particular GABA-enriched rice mentioned by the interviewee is created through genetic translocation within the same rice species (the interviewee did not use the term genetic modification and was opposed to call his research product by that name as it does not contain any genes from foreign species). Since GABA is to be concentrated in the rice germ, it is crucial not to hull the rice completely and leave the rice brown. Along with other types of natural brown rice, carefully hulled to allow its germ to sprout (and thus increase the amount of GABA by more natural processes), GABA-enriched brown rice has been marketed as a functional food in Korea

[38] Researchers interviewed are designated by pseudonyms.

since the late 1990s. Thus, the transition that brown rice has gone through is evident. It used to be considered a lower-grade rice supported by a developmental government. Even though health benefits were briefly mentioned by President Park, it was still only an ancillary motive for consuming brown rice, compared to its cheaper price. Yet after the late 1990s, brown rice became known as the variety with more GABA and more health benefits than white rice.[39] Usually the price of packed GBR is four to five times higher compared to white rice.

What Professor Kang recalled were two types of transformations. Firstly, the research agenda in agro-food science changed from increasing crop yield into making value-added agricultural products with an appeal to the health-conscious consumers. Several Korean governmental reports discussed in Chapter 2 also echo Kang's remark that the main agenda of agro-food research and development have changed in accordance with the Korean social transition (Chang, Park, & Ha, 2003). Secondly, he noted the importance of new materials in his research. After the 1990s, the bioactive molecules with health benefits (such as GABA), rather than a rice variant as a new species (such as IR667), have become the focus of his new projects. There is an evident connection between the first and second type of change occurring in Kang's laboratory. Moreover, the emergence of GABA entails another type of change—transformation in Korean research universities.

Korean science and technology (S&T) policy environment changed rapidly after the late 1990s. A new Korean government led by President Kim Dae Jung commenced "5-Year Science and Technology Innovation Plan" in 1998 which proposed to increase Korean scientific R&D spending to the total budget to 5%, which is similar to the level of the US. ratio. The new plan was also unique in that it targeted basic and fundamental research. According to Chun Eui Jin, a MOST official, "we had supported industry [but] as our capability goes up, we step back to more basic research." Indeed, the government had already increased expenditure to support industrial

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[39] Between the late 1970s and the late 1990s, the 1980s and the early 1990s need to be mentioned as the first phase when brown rice started to be featured as "healthy" foods rather than as low-grade grain in Korea. Ahn, Hyeon-pil, who wrote weakly columns on healthy foods and lifestyles from 1992 till 1995 in *Hankook Ilbo*, advocated regular consumption of brown rice instead of completely dehulled white rice as a healthy habit (Ahn, 2008). Like in the US, fiber was regarded as a popular healthy macronutrient in Korea during the 80s and was often symbolically associated with "rough" and primitive nature. I omit this period in my dissertation as it does not directly pertain to my main interests in how specific health benefits of foods and concerns over lifestyle-related diseases are constituted since the late 1990s. For the same reason, I did not include an overview of brown rice culture in rural Ameican hippie communes in the early 1970s (Hartman, 2003).

R&D during the early 1990s (see Table 5). As Korea achieved some success in industrial technology—especially with DRAM semiconductors and CDMA cellular phones taking the largest global market share since 1998—Korean MOST saw the necessity in cultivating basic research for the future growth (Baker, 1998; Kang, 1998).

The original goal of budget boost was not achieved partly because of the East-Asian financial crisis that started almost simultaneously with the launch of the 5-year plan. According to an Organisation for Economic Cooperation and Development (OECD) report, Korean governmental R&D investment increased modestly—from 2.8% of the total budget in 1997 to 3.6% in 1998 and to 3.7% in 1999.[40] The attempted shift away from supporting R&D by large corporations toward more fundamental work at universities was also weakened after the revision of the plan. The revision made in December in 1999 after the financial crisis reduced investment in the fund for basic scientific research from 300 billion won to 160 billion won (Organisation for Economic Cooperation and Development, n.d.).

Nonetheless, Korean S&T policy environment changed enormously during the late 90s. The Brain Korea 21 (BK21) program started in 1999, 21st Century Frontier R&D Program was initiated in 1999, the Creative Research Initiative (CRI) in 1998, and the National Research Laboratory (NRL) commenced in 1997. What was even more noticeable than the increase in governmental funding for university-level research was the principle of "selection and concentration" adopted by Korean government. The principle of "selection and concentration," which summarizes Korean government's historical tendencies to support large corporation as the main driving force of national economic development was apparently appropriated as the key moral in its support of basic research as well (Yim, 2006). There was fierce competition among universities when the Korean Ministry of Education and Human Resources launched the BK21 program with the budget of about 1.3 trillion won (about 1 billion US dollar). The program selected only fourteen university research teams as grantees of 200 billion won per year for seven years, and Professor Kang's laboratory was one of them.

With the BK21 program and other similar projects, the Korean state funding for university-level research was distributed in an extremely disproportionate manner after the late 1990s. Food scientists' participation in numerous functional food projects coincided with such changes in

[40] The difference in the estimated percentage of R&D spending between the statistics from Korean Ministry of Science and Technology and that from the OECD report might come from their different definitions of spending for R&D.

universities. Two laboratories at Seoul National University, one at Yonsei University and two in Korea Research Institute for Bioscience and Bioengineering (KRIBB) have been selected as National Research Laboratory (NRL) by the Korean Ministry of Science and Technology to carry out functional food research related to lifestyle-related disease prevention. Several other functional food-related research teams at Seoul National University, Yonsei University, Kyungnam National University, Kyungsang National University, Inje University, Kyungbook National University, Gonguk University, and Sejong University have been selected as BK21 project grantees. In all of the selected laboratories, functional food-related research is carried out with a focus on bioactive components working on cellular and molecular level, rather than on nutritional level.[41]

In particular, professor Kang and his collaborators' research was selected by MOST as one of 100 successful national R&D projects between 2003 and 2005. Under the title of "Developing Natural Functional Rice 'Jumbo Germinated Rice': A New Rice Variant with Enhanced Bioactive Components [Cheon-yeon Gi-neung-seong SSal 'Geo-dae-bae-a-mi' Gae-bal: Geon-gang-gi-neung-seong seong-bun-i gang-hwa-deon sae-lo-eun ssal pum-jong]", Kang's research was summarized with a particular emphasis on GABA and its claimed benefits for neuronal metabolism. Kang's collaborator in another university, who also published several research articles on health effects of GBR and GABA remarked in the interview:

> I came to be interested in healthy molecular components in foods or development of functional foods since 1992 or 93. Before that I was interested in enzymes [and its macromolecular characteristics]. Germinated brown rice is the hype these days but the idea is just the same as any crop varietal improvements. GABA is not that special. GABA is just another metabolic intermediates produced from amino acid metabolism. But these days it is hard to get funding with basic research [such as characterization of enzymes in rice]. We need to do BrainKorea projects [and get funding from the Korean government] (J. Min, personal communication, July 17, 2007).

[41] For the examples of functional food laboratories participating in BK21 program while focusing on molecular bioactive components, see the following laboratory websites run by Yonsei University (http://ybri-bk21.yonsei.ac.kr/eng/index.asp), Inje University (http://home.inje.ac.kr/~fdsi/sub3-3-2001.htm) and Kyungbook National University (http://webbuild.knu.ac.kr/~phytochem/community/html/s3_1b.html) as BK21 grantees.

Korean MOST aimed to support "basic" research by increasing R&D budget for universities, rather than for large corporates. However, not all researchers at universities found that their basic research was being supported by the government's large-scale projects run under the principle of "selection and concentration". Instead, some agro-food researchers expressed that they were transforming their laboratories in order not to lag behind. Even though some researchers might personally think that GABA is "just another metabolic intermediate" as trained nutritional biologists, they nonetheless participated in connecting agro-food science and biomedical science through GABA. Another researcher expressed ambivalent feeling toward the focus on molecular bioactive components in functional foods.

> I think when we do research on functional foods we need both molecular biology and classic nutritional science [for more macro-level analysis]. But you cannot just do nutritional science because then you cannot deal with the current things like signal transductions in cellular levels and as such. If there is one antioxidant molecule [in a food], let's say, then it is much more meaningful to specify how it works in cellular and molecular levels [than to claim broad health benefits]. The old methods of food-nutritional science look only macronutrients [such as carbohydrates or proteins]. I think more molecular biology should be employed if we want to better understand the actions of functional foods. It is hard to carry on research. But we have to try and directly pinpoint the bioactive component in the food as best as we can (S. Jeong, personal communication, July 15, 2007).

Studying GABA instead of enzymes or macronutrients was not a simple change for food scientists. Food scientists had to acquaint themselves to specific sets of goals, apparatuses, techniques, and references, most of which did not exist until the late 90s in Korea. I asked several food scientists who led functional food-related research projects as principle investigator to explain what they went through during the 1990s.

> Kang (Interviewee): My main research interest has been consistent—I aim to improve [the quality of] rice. The way to achieve that improvement can be through increased productivity or through bioactivity [for health benefits].
>
> I: So the aim of agro-food research could be focused either on productivity or bioactivity. Then, are the two research practices similar? Do you perform the same experiments but just focus on different molecules?
>
> Kang: No (smile). When you have a different goal, everything has to change. You need to start with different raw materials and use different tools. Besides, before the 1990s, "molecules" were not important in agro-food or nutritional science. When you characterize

a new product obtained from breeding, you don't always have to go to molecular level (J. Kang, personal communication, January 20, 2008).

Min (Interviewee, a grantee of the BK project): We cannot get funding if we do basic research. We have to commercialize our research by all means. If our research is not applicable to the industry, we cannot get research funding. That's why I came to focus on rice bran. [I think] a researcher should be able to keep his/her methodology until s/he dies. That [consistency] makes research marvelous, mature […..] that's the best. But I have to change everything because they [funding agencies] want the change. All the methods, apparatuses, they are all different. Books are different. We have to change our minds completely, too. I don't force my graduate students who have been in my laboratory for a while to change [their methods]. I can't force that to kids. But I, at least, have to change. This way and that way. I'm almighty (J. Min, personal communication, July 17, 2007).

Yeo (Interviewee): The experimental methods used in traditional nutritional science or agricultural science were not specific enough. I think this trend [focusing on micro-level molecular bioactive components] will be strengthened as the university-industry collaboration increases and governmental funding [for the development of rice variant species, which takes a long time] decreases. The academia is able to and maybe, in a sense, now obligated to suggest companies that such and such bioactive molecules [shows bioactivity]; and then the companies will be able to make actual [functional food] products for commercialization. Departments of Agriculture in Seoul National University changed its name into Departments of Bio-agriculture. All the other universities are like that. Is agricultural science disappearing? We now focus on value-added agro-foods, bioactivities and functional foods. But the high-yield variants developed in the Korean Rural Administration were great technological accomplishments. They are great achievement, no less than Hyundai cars. But the government does not think that productivity is an important issue any more. We cannot have stable environment for step-by-step agricultural research because [the governmental R&D policy] keeps destructing and reconstructing (S. Yeo, personal communication, January 22, 2008)

Some expressed explicit concerns over the change in agro-food research. According to some interviewees, agro-food scientists were "losing their characters." Except for a few "selected" laboratories with "concentrated" governmental funding, university laboratories could not carry on any type of basic research at all. Whilst Korean government decided to invest more in basic university-level research as the new driving-force of economic growth, selected researchers who consider themselves already doing "basic" research also found that they had to change their research projects to become more applicable to industries and markets. It is considered as problematic to invest too little in developing high-yield variants. Still, agro-food researchers found it difficult not to pass through molecular bioactive components because without them their research would be "just nutritional science" which is "not specific enough" to "deal with the current things." Such research would not be considered as research worthy of "selection and concentration".

To apply Fleck's terms, transformation of brown rice from lower grade rice to functional food is connected to the changes occurring both in *esoteric* and *exoteric* circles. Developing Tong-il and achieving rice self-sufficiency in Korea was the shared research goal for both Korean politicians and food scientists during the 1970s. Both politicians and scientists were ready to take the course of the Green Revolution, increase the productivity of rice and distribute mass-produced technoscientific products to the public. On the other hand, GBR development after the late 1990s was accompanied by agro-food researchers directing their focus toward GABA and Korean government's principle of "selection and concentration" in supporting university-level research. Korean government aimed to direct its economy even more closely toward knowledge-based innovation by encouraging cutting-edge S&T research in universities. Meanwhile, agro-food researchers in universities came to transform themselves into new types of scientists—experts of molecular bioactive components, who occasionally collaborate with medical scientists.

> Brown rice with bigger germ could reduce the level of triacylglyceride. (……) I didn't test bioactivities of brown rice because the procedures cost so much money with lab animals, analyses and so forth. So I collaborated with medical science laboratories and nutritional science laboratories. The trials took years! And what they [medical science laboratories] found was the bioactivity for lipid metabolism. I don't know but they say lipid metabolism and cholesterol contents are all related to diabetes… It's like that the rice can work somewhat strangely like medicine (……). One of my lab graduates founded a biotech start-up company in the university research park. I invested in the company even though I don't have much…. And, you know, I sometimes met some news reporters (to) take photos and stuffs. It's just last year [2006] that the company started to sell some [commercial functional rice products], though it's still such a small company compared to the US. agro-biotech companies (J. Kang, personal communication, January 20, 2008).

In the next section, I will direct my focus toward the media's practices in constructing the connection between bioactive molecules, foods and medicine. The media's practices will then be analyzed in relation to the role of exoteric circles affecting the thought-styles of esoteric experts.

4. The Practices of the Mass Media

Conventional wisdom says that media accounts, such as the picture of thin woman in front of rice bowl, simplify the contents and contexts of food scientists' research. Newspaper articles and advertisements need to be shorter than the original research articles; and they are intended to be read by the lay public who have more interests in the direct applicability of the research outcomes rather than in academic contexts.

The two advertisements featured in Figure 7 show GBR-making rice cookers—one of them is manufactured by a Korean company specializing in rice cooker production and the other by a Japanese one. The two electric pressure cookers basically germinate brown rice before cooking; and set up the pH and temperature of the water for the maximum increase of GABA in the cooked brown rice. Both advertisements make the word "GABA" stand out to emphasize the added-value of their rice cooker products in terms of health benefits. "Increasing the metabolism of neuronal cells and thus improving memory," "preventing and lessening climacteric, menopausal and pre-senile disorders," and "reducing the level of bad cholesterol and neutral body fats" are mentioned as the key health benefits of GABA in the left advertisement.

What is often omitted in case of GBR research is a weak connection between GBR and GABA. Food scientists often state that the goal to explain the health benefits of GBR by a neurotransmitter is *not* achieved *yet*. Subsequent excerpts were selected as they reveal food scientists' typical writing styles in stating the health benefits of GBR and bioactivities of GABA.

> Because GABA has an inhibitory effect on peptic output in anesthetized rats, the decrease in serum and hepatic lipid levels *might be due to* retardation of ethanol absorption and metabolism *resulting from the presence of GABA* (Oh et al., 2003, p.119, emphasis added).
>
> *Taken together*, the large amount of *GABA in PGR* [note: Ukai uses the word 'Pre-germinated Brown Rice' instead of germinated brown] *may regulate* the glutamatergic system by enhancing glutamate release and/or the sensitivity of NMDA receptors, resulting in memory enhancement (Mamiya & Ukai, 2004, emphasis added).

These nuances and hesitations are apparent when compared to the food scientists' straightforward statement on the GBR's health benefits for some chronic symptoms.

> Although the spontaneous alternation behavior of both cornstarch and polished rice groups (of mice) was impaired by Ab, *no such impairment was observed* in the PGR group without changing total arm entries (Mamiya & Ukai, 2004, p. 1044, emphasis added).

> The administration of germinated brown rice extract *reversed the deleterious effects of ethanol* on serum and liver lipids (Oh et al., 2003, p. 119, emphasis added).

Why do food scientists make such hesitations when stating the relationship between molecular bioactive components, foods and health benefits? Several food scientists that I interviewed mentioned the difficulties in making a direct relationship between one bioactive component and a functional food.

> It can be controversial if you say one compound in a functional food is really good for health. Of course, the most important thing in functional food research will be pinpointing what compound in the food is good for [potential] patients. And we also need to establish good methods to quantify and analyze the active compound in the food. However, when you talk about functional foods, you also need to know that food is not a simple thing. Things like how you cook the food, like if you stir-fried or if you chopped, will enhance or prevent [the adsorption of] the active compound in the food; and it is not simple. The bioactive compound will, after all, function as [a part of] a food (S. Jeong, personal communication, July 15, 2007).

> Rice is not like purified chemicals. I try to separate a food into several portions of chemically-homogeneous mixtures [before I see the actions of the food] because my academic background is biochemistry. Yet it is almost meaningless to separate a food into single molecules—most times you will not see bioactivity [or health benefit] if you just obtain singularly separated molecules. […….] I don't think the current method to assess antioxidant capacities in rice is accurate in strict senses. We use an apparatus called ESR (electron spin resonance) originally used in chemistry for the assessment. Yet because foods are like terribly mixed soup (o-sa-ri-jab-tang), [we cannot study bioactivities of foods perfectly with tools and methods used in chemistry or molecular biology] (S. Yeo, personal communication, July 25, 2007).

However, despite such limitations in pursuing functional food research through bioactive molecules, food scientists' actual practices are strongly *directed* toward making a stronger GBR-GABA connection. The researchers that I interviewed described their readiness to pursue functional food research through bioactive molecules as a restraint that is almost inevitable. A particular force works and drives food scientists to a specific direction. Food scientists are directed to perceive foods through bioactive molecules despite remaining uncertainties. Such thought style limits food scientists' research in terms of tools and methods; and yet simultaneously, it *enables* food scientists to achieve *vividness for presenting* their research. Below I will use three examples of food scientists' presentation of their research affected by the readiness to perceive GABA in GBR.

The first example comes from a presentation in Rice Conference in February, 2004 (organized by Food and Agriculture Organization [FAO] of the United Nations). Ito Shoichi, professor at Tottori University in Japan, emphasized the increase of GABA in GBR with a vivid image in an attempt to reach to a broader range of audiences.

> Nutrition of germinated grains has been studied since decades ago. …… Saikusa, Horino and Mori (1994) found that γ-amirobutyric acid (*GABA*) increased dramatically if brown rice is soaked in 40 degrees in Celsius water for 8 hours to 24 hours. Okada *et al.* (2000) reported that intake of GABA for 8 consecutive weeks *suppressed blood pressure and improved sleeplessness, and autonomic disorder observed during the menopausal or presenile period* (Shoichi, 2004, p. 2, emphasis added).

Shoichi's presentation gives emphasis on GABA enriched in GBR. Further, he links the functional food GBR to amelioration of various lifestyle-related diseases—high blood pressure, insomnia, and dementia. Unlike the research articles discussed above, Shoichi's presentation is not characterized by hesitation before making connection between GABA, GBR, and lifestyle-related diseases. In addition, the graph (see Figure 8) in Shoichis article emphasizes greater increase of GABA in GBR compared to white rice than any other components such as fibers or iron. The graph provides the attendants in the FAO Rice Conference with the impression that GABA-enrichment is one of the most significant changes occurring to rice after germination.

The second example comes from a Korean researcher Oh's published article. Similar to many other research articles, Oh summarized known health benefits of GABA briefly and connect their research on GBR to the studies of GABA.

> It is well known that GABA functions in animals as a major inhibitory neurotransmitter. GABA is involved in the regulation of cardiovascular functions such as blood pressure and heart rate, and it plays a role in the sensations of pain and anxiety. [……] Several lines of evidence suggest that plant extracts containing high levels of GABA are effective for improving blood pressure regulation and for recovery from alcohol-related symptoms. However, to date no attempts have been made to investigate the effect of rice extracts containing high levels of GABA on lipid metabolism and liver function in chronically alcoholic animals (Oh, et al. 2003, p. 116).

A statement such as "rice extracts containing high level of GABA" provides succinct information to other food scientists (who are not necessarily directly involved in GBR research) that GBR contains a high amount of a major neurotransmitter with health benefits. "Alcohol-related syndromes" or "chronically alcoholic" draw the attention of readers who are interested in lifestyle-related diseases.

The third example is from a review article published in *Nature* (Surh, 2003), written by a Korean scientist working on phytochemicals in diverse functional foods. The picture used in *Nature* shows that visual connection between a bioactive molecule and a food is not exclusively made in the mass media or presentation for the lay public. Bioscientific experts produce and circulate vivid images presenting functional foods, bioactive molecules and health benefits together when they attempt to reach to a broader range of audiences including scientists in other fields (see Figure 9).

The above three examples do not dispute the claim that scientific information produced in the esoteric circles of food scientists are simplified as the news articles and advertisements translate the information for their readers. I also do not deny that there are cases where the mass media accounts omit details. For example, "prevent[ing] the Ab-induced impairment of spontaneous alternation behavior" is translated into "improving memory." And "revers[ing] the deleterious effects of ethanol on serum and liver lipids" is translated into "lowering the level of cholesterol." The bioactivities observed in laboratory experimental animals are translated into health benefits for humans. The mass media also occasionally omit scientists' careful statement that GABA "might" explain the healthy actions of GBR. Instead, the increase of GABA in GBR is often presented as the objective scientific evidence that *explains* the healthy action of GBR. As a result, the connection between GABA and GBR that food scientists made carefully by juxtaposing their speculation and expectation, the inconclusive results and the practices toward constructing better-equipped laboratories for research at molecular level, becomes much simpler as it is translated by the media in Korea. As Nelkin (1987) notes, scientists often criticize the media for falling short of conveying the accurate scientific information. The media are said to entertain and focus on scandals—such as competition, funding agencies behind scientific research or scientific fraud—and "sell" science to the public, when it could perform a more educational role instead (Nelkin, 1987, 1996). Many food scientists make explicitly skeptical remarks on the role of the press in reporting scientific results. A Professor of Nutrition at Oxford

Brookes University, Conor Reilly (1998) warns that "sober analyses in the mainline broadsheets, and sensational headlines in the tabloids" need to be made in scientific journals whilst the health benefits of selenium are covered widely by the press. Sylvia Rowe (2002) in International Food Information Council criticizes the media coverage on functional foods more directly: "When any scientific study is concluded, it is unlikely that its findings will be the final word on a subject. [……] Conversely, news stories are judged by their instant appeal—the impact of a headline or the allure of a sound bite. Scientists might view the practicality of a specific study's conclusion much differently than those who report the information to the public. This incongruity between science and media not only perpetuates misinformation and 'junk science' but also fails to provide the wider context that gives single scientific conclusions their meaning."

Yet simplification is not intended for "junk science" only. In his analysis of thought style, Fleck (1979) focused on the "vividness" achieved in knowledge and its special effect of making an idea comprehensible to others. For example, the lock-and-key symbols of antibody-and-antigen are used in the educational texts of serology to vividly present the theory of specificity. Whilst Fleck argued that ideas achieve more emotive vividness as they move from the esoteric "center" toward the exoteric "periphery," Fleck's idea is far from the diffusion of knowledge from the experts to the lay public. Importantly, Fleck argued that the vivid image "prevails over the specific proofs and often returns to the expert in [this] new role" (Fleck, 1979, p. 116) of making an idea more clearly comprehensible. Fleck's argument that the theory of the Wassermann reaction is established on a "popular" concept of the lipoid bodies which differs from the concept of the lipoid bodies held in chemistry is noteworthy. The argument speaks against the common stereotype that popularization of science occurs only in the "periphery" of scientific knowledge production. The stylized mode to perceive things in scientists' laboratories is affected by emotive vividness achieved in the exoteric circles.

The above three examples illustrate that "simple" and "vivid" connection between foods and bioactive molecular components are not made exclusively by exoteric circles. The vivid connection between GABA and GBR was produced before complete scientific conclusion in exoteric circles. The media often omits scientists' carefully statement that GABA "might" explain the healthy actions of GBR. Instead, the increase of GABA in GBR is often presented as the objective scientific fact that *explains* the healthy action of GBR. As a result, the connection between GABA and GBR becomes much simpler as it is translated by the media. Then, this simplified accounts come back to food scientists as a visual tool to present their research to a wide range of audiences—including scientists in other fields and the lay public. In this sense, simplified knowledge is not made exclusively *for* exoteric circles "selling" science, either.

Simplified knowledge can also work as faith in the ideal of knowledge as Fleck argued with his example of Wassermann test. Although food science is like analyzing "terribly mixed soups" with tools for chemistry and molecular biology, food scientists express that they "have to try to *directly pinpoint the bioactive component* in the food as best as we can". See for example, the excerpts from Oh et al.'s research article stating his future research agenda.

> Further study is needed to determine how GABA-rich brown rice extracts modulate the effects of ethanol metabolism and to *elucidate the role of GABA itself* in regulating the metabolism of ethanol and lipids. (Oh et al., 2003, p. 119, emphasis added)

Oh et al.'s focus on GABA rather than on other nutrients in GBR was succeeded by his later article where cDNA of rice GAD (an enzyme that mediates the increase of GABA after germination of rice) in GBR is sequenced. All research projects on GBR in Oh's laboratory includes not just observing health benefits of GBR but quantifying GABA in GBR as well. Thus, the simplified account to vividly connect functional food and health benefits through molecular bioactive components has practical consequences in the laboratories.

5. Vivid GABA and Remaining Controversies

In this section, I will use a specific controversy to examine how such simplified GABA in exoteric circles is connected back to esoteric actors. It needs to be noted that GABA was first discovered as a neurotransmitter (known as our brains natural "tranquilizer") and were subsequently studied as bioactive molecular component in foods. I start this section with an interview with a neuroscientist, Audie Leventhal by *ScienceCentralNews*, arguing that eating GABA will not give health benefits.

> Why do some elderly people have difficulty with vision, speech, and mobility? Some neuroscientists have turned to monkeys for the answer, and believe it might be because of a brain chemical called GABA.

> “Our subjects were literally the world’s oldest rhesus monkeys,” says Audie Leventhal, professor of neurobiology and anatomy and adjunct professor of physiology at the University of Utah, School of Medicine. (……) “In addition to looking like old people, having grey hair, wrinkles, and so on, they [the very old monkeys] have cognitive declines. They don’t move as quickly. They have more difficulty doing complex tasks as they get older.” Leventhal explains in the May issue of *Science* that as we age, nerve cells in the brain become less “picky” about which signals to respond to and which to ignore, and this could be because our brains make less of a chemical called gamma-aminobutyric acid, or GABA, as we get older.
>
> Before you go out and buy up all kinds of dietary supplements with GABA, a word of caution from Leventhal: “*GABA itself does not pass through the blood brain barrier*, so eating it will be of little value. Drugs that increase GABA inhibition [note: here ‘inhibition’ does not mean the inhibition of GABA but the action of GABA as an inhibitory neurotransmitter] are potentially useful” (“Got GABA?”, 2003).

The above news article firstly introduces a neuroscientists’ research and then later reveals conflicts between functional-food research and Leventhal as a neuroscientist. Leventhal and his colleagues published a research article on the effect of GABA on the electric activities of visual neurons in *Science* in 2003. In their research, Leventhal directly injected GABA into the brain of monkeys and compared the neuronal activities of the monkeys to a control group. This experimental step shows a marked difference between food scientists’ approach, which is to feed GABA-containing foods to experimental animals. Leventhal’s article was reviewed in the news section of *Science* as well, reflecting the high level of interests generated by this particular research finding—that decrease in GABA may explain the declining visual cognition with aging. In the above news article in *ScienceCentralNews*, Leventhal suggests that pharmaceutical drugs enhancing the action of GABA may prevent the cognitive decline in old people.

> “We were able to have the cells respond more like cells do in younger animals as long as we were delivering the GABA,” says Leventhal. (……) Leventhal hopes to test GABA-boosting drugs in humans, which could make nerve cells pickier in aging human brains. “If, in fact, older humans are deficient in GABA, and don’t have enough inhibition in their brains, you may actually be able to improve or speed up the operation of the old brain by tranquilizing it, by using drugs that were developed as tranquilizers. No one has ever thought of that before, because the last thing you want to do to your grandfather is [to] tranquilize him because he’s moving too slowly (“Got GABA?” 2003).

Along with this interest in employing GABA-boosting drugs to improve the operation of brain activity in old people, Leventhal expresses his skepticism against GABA-based foods. The blood-brain barrier (abbreviated as BBB), that Leventhal mentions in his interview with *Science Central News*, is a physical barrier between the blood vessels and the brain that stops many substances from traveling across the barrier. BBB, as a relational object, fortifies the connection between GABA-based pharmaceutical drugs and health-benefits. Descriptions of GABA-based pharmaceutical products to scientific and lay audiences sometimes include explicit references to their abilities to cross the BBB. For example, there is a research article abstract stating that "gabapentin *passes the blood-brain barrier*" (Luer et al., 1999, p. 559, emphasis added). Furthermore, Epilepsy Professionals (http://professionals.epilepsy.com/), a website with information on epilepsy, states that "neurontin was formed by the addition of a cyclohexyl group to gamma-aminobutyric acid (GABA), which allowed this form of GABA to *cross the blood-brain barrier*." Pharmacy Times (http://www.pharmacytimes.com/) also contains information on GABA-based pharmaceuticals including the statement, "Lyrica is a lipophilic analogue of gamma-aminobutyric acid (GABA) substituted at the 3-position to facilitate *diffusion across the blood-brain barrier*" (Faria, 2005). All of the above information available to scientists and health-concerned pharmaceutical consumers emphasize that those major GABA-based drugs are designed to cross the BBB.

In pharmacology, the practice of "substituting" chemical functional group in GABA makes GABA-based drugs superior to GABA in foods. Leventhal's interview with the *Science Central News* shows how this practice of chemical substitution is mobilized by neuroscientists to weaken the position of GABA in functional foods. The quarrel is, on one hand, about whether GABA does or does not cross BBB. Yet it also addresses the context where two different academic disciplines have different nonhuman allies—"natural" food vs. "better-than-natural" drug. In addition to the news article in *Science Central News*, the argument that orally-administered GABA cannot cross the BBB can be found widely in health-related articles targeting lay people in the US. Julia Ross's (2002) book "The Mood Cure" also uses lay language for stating that food-originated GABA cannot cross the BBB "which protects your brain against the mayhem of nutrients" (Ross, 2002, p. 28).

This BBB controversy is, however, not as simple as the article in *Science Central News* or in other popular media sources declare. Several food scientists' studies focus on the BBB controversy and demonstrates that food-originated GABA could bring health benefits when orally administered (Hayakawa, Kimura, & Kamata, 2002; Hayakawa, Kimura, & Yamori, 2005; Hayakawa et al., 2007). Briefly, some of the research demonstrates that a small amount of GABA can cross BBB, or that GABA can generate physiological effects through the peripheral neurons which are not blocked by BBB. In doing so some food scientists' research on orally-administered GABA argues against Leventhal and other neuroscientists' exclusive prioritization of GABA-enhancing drugs. It is reasonable to conclude that the BBB controversy still remains as an on-going debate. However, *neither the Korean nor the US media* features the controversy in sufficient scientific detail. In Korea, the BBB controversy is not included in the media coverage on GBR. In the US, research findings suggesting that GBR could provide the health benefits of GABA without crossing BBB are not covered in the media accounts on GABA-based pharmaceuticals.

How should this "simplification" of the BBB controversy be interpreted? As argued in the previous section, what the media achieves by "simplification" is more than omitting details in scientific findings. Through simplification, the Korean media provides a vivid image of food science and biomedical science connected through molecular bioactive components such as GABA. Meanwhile, the above articles released by the US media strengthen the connection between pharmaceutical science and GABA, as they provide simplified conclusion ("GABA itself does not pass through the blood brain barrier, so eating it will be of little value"). This strengthened connection becomes available for consumers who make an informed choice between buying GABA-based functional foods or GABA-based pharmaceuticals.

In addition, what the media delivers from esoteric circles to the public is not limited to bioscientific information in its simplified form. The media also provides a summary of the current socio-cultural environment for functional foods to a wide range of audiences including the public and science policy makers. For example, a special report on Tong-il by *Hankyorae21* (Cho, 2000) reproduces the notion that Korea has moved from a centralized developmental state to a flowering consumer society by revoking the collective memory of Tong-il rice.

> What made food shortage a by-gone history was Tong-il rice, which was called "the green revolution." The successful cultivation of Tong-il by Korean Rural Development Association in 1971 was like the Gospel to Koreans in starvation. (……) Korea finally

> achieved its self-sufficiency in rice in 1975. In 1977, Korean government removed the prohibition on rice wine for the first time since 1966 (……).
> Yet Tong-il's weakness was its non-sticky taste, which made Korean consumers turn away. After the 80s, Tong-il gradually disappeared from the field and in the 90s, practically no Tong-il was planted any more. Tong-il rice, which liberated Korean people from agonizing starvation, has left our land. Consumers came to prefer "regular rice" (*ilbanmi*, meaning rice that is not collected or subsidized by the government before trade) to "government rice" (*jeongbumi*). [……] Now we regard rice as the commodity in the [liberal] market (Cho, 2000).

The notion of rice as market commodity that can appeal to health-conscious consumers is strengthened by the cultural work of the Korean media texts. Scientists in universities also participate in reproducing the "simplified" argument that through enhancing the quality of rice through biotechnoscience, Korean rice can be competitive in the global market. In their articles contributed to the general press, scientists tend to focus less on "a specific study's conclusion," but rather express their expectation for functional foods. In a contributed article in a major Korean newspaper *Donga Ilbo*, Professor An, Gynheung (2004) at Postech argues that functional rice such as "nutritious rice bran" or "colored rice with a high amount of flavonoids, a healthy bioactive component in red wine" could enable Korea to compete with other countries in the "$500 billion global rice market."

Media coverage on GBR also commonly portrays GBR and related products as parts of the "well-being trend," which refers to heightened consumer demand in healthy/green products in Korea.

> Last year's popular [healthy food] product was black bean. This year it is GBR. As "well-being" fever becomes hot, an increasing number of consumers seek GBR-based food products for health and nutritional benefits. GBR contains 2-10 times more GABA than white rice. It is known to suppress the fat absorption and stimulate brain activities. "Haet-ban Bal-ah-hyeon-mi-bab" from CJ is leading the market. This product was released to the market last year and made 5 billion won (about 5 million dollar) sales. CJ sees this record encouraging considering that it was the first year. CJ aims 10 billion won sales this year (Ko, 2004).

> Samsung electronics meet consumers' demands for "well-being" with its new Kimchi refrigerator. As Kimchi refrigerator has been in the market for more than 10 years, now it needs to expand its functions to other healthy foods such as yogurt. A new Kimchi refrigerator made by Samsung can store Kimchi, germinate brown rice and make yogurt as well. [……] As well-being foods can be made easily by this product everyday, this

> refrigerator is suitable for young housewives considering the value of healthy food products highly (Yoon, 2006).
>
> Brown rice is an exemplary well-being food. Brown rice contains germs and bran, as it is not completely hulled. An interesting fact is that brown rice contains 8mg of GABA per 100mg, while white rice contains 5mg. Experimental results demonstrate that GABA improves hypertension and strengthens the action of kidney and liver. [……] The amount of GABA in brown rice increases around three folds after soaking in the water. After more than 20 hours of soaking, 0.5 to 1 mm long sprouts are observed from the germ part. Such brown rice with sprouts is called germinated brown rice [bal-a-hyeon-mi] (Ko, 2007).

In particular, whilst media coverage of GBR and other functional foods emphasizes food quality and competitiveness, those characteristics are frequently connected to health benefits and molecular bioactive components (GABA) contained in the foods.

> As Korean gross national income per capita approaches $20,000, the quality of foods is being upgraded. The "well-being" trend in recent years stimulate the food industry to keep marketing new products fortified by nutritional components and bioactive function. [⋯⋯] Dong-won F&B [food and biotech] released "100% germinated brown rice" last June. This product contains more nutritional components such as dietary fiber, protein, calcium, phosphate and vitamin; it also contains a rich amount of GABA (Gamma Amino Butyric Acid). The marketing concept of this product is health (Lee, 2007).
>
> The well-being trend is apparent in electronic rice cooker market. Premium rice cookers do not simply cook rice; but germinate brown rice or increase the amount of GABA in brown rice without problem to meet choosy modern people's demand (Choi, 2006).

What the media does by "simplification" is, thus, more than omitting details of scientific findings and creating hyped expectation for a magic bullet. This simplified connection among GBR, GABA and health benefits constructed in Korea does not distort the truth that GABA does not cross BBB, as claimed by Leventhal or the US media. Rather, the Korean media constructs a particular association of GBR, GABA, health benefits, competence in the global food market and the well-being trend. Here the meaning of GBR as "food" becomes important and GABA becomes a factor that adds values to functional rice. Meanwhile, the US media strengthens the connection between pharmaceutical science and GABA, as news articles provide simplified conclusion that "GABA itself does not pass through the blood brain barrier, so eating it will be of little value." This strengthened connection becomes available for the consumers who make an informed choice between buying GABA-based functional foods or GABA-based pharmaceuticals.

By this account, I do not aim to make a simple argument that the US. media in general tends to support pharmaceutical industry, whilst the Korean media advocates functional food marketing. It needs to be noted that an alternative thought-style for functional food is also evident in the Korea mass media; some Korean journalists express great concern over the safety and/or activity of functional foods. For example, Hong Hye-geol, a well-known Korean journalist and medical doctor specializing in medical news/reports has actively published many news articles expressing his suspicion over functional foods. In his book published by *Joong-ang Ilbo* Press, Hong writes a chapter on "bioventure and functional foods." Hong uses strong language to make a vivid contrast between "cutting edgy bio-venture companies and functional foods resembling rugged [*gu-dak-da-ri*] alternative medicine" (Hong, 2005). The chapter is particularly interesting as it shows an overview of anti-functional-food narratives. "Developing hundreds of functional food products is no problem, as it simply requires plants existing in nature and does not need to go through painstaking research of [chemical] synthesis" or "functional foods do not need to go through strict bio-safety tests" exemplify some Korean media's concern over Korean biotech industry competence. The assumption is that if Korean biotech industry focuses too much on functional food development (which is "low-tech"), it will lose competency in pharmaceutical development (which is "high-tech"). The disproportionate growth of the functional food sector in Korean biotechnology is sometimes attributed to Korean funding agencies focusing only on "short-term" profits. Such accounts portray Korean funding agencies to have limitation in carrying out long-term policies to support "real" high-tech biotechnology such as pharmaceuticals or genomics. Hong's other narratives including "the bioactivity of functional foods can be obtained by clinical experiments performed by some professors in poverty", "it is only a common sense that statistics can make up any conclusion that researchers want," and "even though functional foods show some effects, it could be because of placebo effects" exemplify some Korean media's concern over "gullible" consumers. The simplified frame of understanding here is that consumers want "magic bullets" and tend to buy hyped-up functional foods unless they are advised properly by the unbiased experts.

Even such a brief look at Korean media coverage on functional foods reveals that the media apply heterogeneous frames to the research and development of functional foods; and what "the media" does for one knowledge-industry over another cannot be easily generalized. Thus, I do not argue that the Korean media in general supports functional food industries, whilst the US. media tend to aid pharmaceutical industry. Furthermore, the purpose of this chapter was not to provide a sweeping overview of the media coverage on functional foods.

Rather, I explicated how a *particular* thought style, such as the readiness to study the health benefits of GBR through focusing on GABA, emerged as the interaction between researchers and the media. As discussed in the previous section, scientists express that there remain ambiguities in the connection between GABA, GBR and health benefits. However, scientists' readiness to focus on GABA is accompanied by actual practices. For example, Oh et al.'s research article in 2005, which report the genetic sequence of RicGAD (an enzyme which catalyzes the production of GABA in rice) is not a result of passive observation alone but rather a product of directed readiness to perceive GABA in functional rice. The website of GeneBank (http://www.ncbi.nlm.nih.gov/entrez/viewer.fcgi?db= nucleotide&val=59940381) run by NIH provides all the genetic sequence of Ric GAD deposited by Oh's research team. This genetic sequence (see Figure 10) enables further research on GBR on a molecular level.

> In the present study, we report the structural and functional characteristics of a novel GAD clone, RicGAD, derived from rice. The 1,712 bp nucleotide sequence of RicGAD harbors an ORF consisting of 505 amino acids, and nontranslated 5' and 3' flanking sequences, including an 18 bp poly(A) tail. The entire RicGAD cDNA nucleotide sequence exhibited 84.5% and 54.7 % identity to the rice GAD sequences deposited in the GeneBank database, OsGAD1 (AB056060) and OsGAD2 (AB056061), respectively (Oh et al., 2005, p. 1).

Critique on the media in terms of what it does *not* feature will not address how it contributes to knowledge production. By not covering scientific information either on "GABA crossing BBB" or on "GABA not crossing BBB," the Korean media construct simplified connection between bioactive components that is easily understandable without ambiguities. The Korean media also reflects and strengthens the connection between the global rice market, health-concerns, the well-being trend, and functional foods. The translation from the experimental results on the laboratory animals onto the human health benefits enables consumers to see more clear connection among food, chronic diseases, and "their" dietary habits. To summarize, the vivid images of GABA, GBR, competitive products in the global food market and the well-being trend is constructed by the media. Importantly, such vivid images are not circulated by and for the mass media only. In a form of directed readiness to focus on specific materials and of certain faith, the vivid image of GABA-GBR affects scientists' practices as well.

6. Summary

Any scientist may easily accuse "the media" as one group of misunderstanding the science, by arguing that some press articles did not report the really credible expert's knowledge and instead focused on biased and/or anecdotal experimental results disguised as scientific facts. Yet it is too simplistic to regard that the media distorts scientific truths and causes misunderstanding because it does not understand scientific research. The media's illiteracy in science may still exist; yet that is not the only and determining factor to produce simplification of scientific knowledge.

Like in the BBB controversy, sometimes scientists who do not agree on the answer to one simple question (can orally-administered GABA make health benefit?) coexist in the same time period. Some conflicts such as Leventhal's attack on GABA-based functional foods might occur but those do not necessarily lead different scientific parties to Armageddon. In such situations where multiple perspectives are held by different scientists groups, one media article usually takes one side and distributes the story narrated by that side only. And the story narrated by scientists on one side to the media is often a "simplified" version, without introducing the on-going controversies.

Fleck's account of the early stage development of the Wassermann reaction mentions that ambiguities and inconclusiveness remain even when researchers orient their experiments in particular directions rather than others. In this sense, Fleck argued that the thought style consists of the *readiness* for selective feeling and correspondingly directed *actions*—such as Wasserman's tuning of their experimental sets until ambiguous results become defined better. In the case of GBR research, the readiness to perceive foods through molecular bioactive components and through health benefits emerged out of the interaction amongst food scientists' knowledge and the media's simplified account on GABA and the well-being trend. Upon this readiness, scientists designed specific sets of experimental protocols to further connect rice to a neurotransmitter and to health benefits. The coupled research work in laboratories and the media enabled GABA in GBR to be perceived readily by the people who have interests in functional foods, cholesterol-lowering or rice cookers.

In this sense, simplification of scientific information is a collaborative process carried out by scientists and the media in pursuit of specific projects. When the media chooses and reports scientific stories from one side instead of another, it combines scientific information and its (expected) social implication as narrated by the chosen side. Such “simplification” does more than exclusion of the details. Production of vivid images with popularized scientific knowledge needs to be seen as a part of the processes through which esoteric circles and exoteric circles interact. Through their interaction, a thought style that weaves GABA, GBR, food science, quality food competing in the global market, and the well-being trend in Korea is constructed.

CHAPTER 4
FROM NEUROSCIENCE TO THE KITCHEN

1. Outline

In the previous chapters, the complex nature of consumers' desire for natural foods was analyzed. During the processes of functional food development, desire for natural foods is connected to multiple factors, which cannot be understood under the previous analytical frameworks of organic foods or conventionalized organic/natural foods. While constructing functional food as a new food category, food scientists and the media come to interact through juxtaposition of vivid images of natural foods and molecular bioactive components. In Chapter 4, I continue to present my empirical findings on GBR and dynamic interactions of multiple actors around the particular functional food marketed in Korea (See Figure 11).

GBR is marketed in Korea and in Japan as a healthy food of which healthy benefits are supported directly and indirectly by research in food science, neuroscience and pharmacology. It is generating roughly more than $30-50 million annual sales in the East Asian market (Cho et al., 2005). The product is commercially available usually as a pre-sprouted form of brown rice in packages with three to four times higher prices than regular white rice. In addition, there are several GBR-related products forming sizable markets (See Figure 12). For instance, a GBR-producing rice cooker made by Cuckoo Homesys in Korea has about $80 million annual market, with further $16 million sales from the export to Japan (Chae, 2005). Another product called "yogurt, cheonggukjang, germinated brown rice fermenter" has at least $30 million annual market. Refrigerators having a special "GBR-storeroom" are produced by Samsung Electronics (Anonymous, 2005a). GBR-containing facial cleansers sold by Ae-kyung Cosmetics also generate about $15 million annual sales and 7.9% of the total facial cleanser market in Korea, which outnumber Unilever's 5.2% and Johnson & Johnson's 4.2% ("Best wel-bing product, Aekyoung "Rice Bal-A-Hyeon-Mi" [The best product for the well-being, Aekyoung "Rice Germinated Brown Rice"]," 2005); Iope samnyeon yeonsok daesang susang [Iope Receives the Best Korean Cosmetics of the Year Three Times in a Row]," 2006). Some of the products manufactured by Korean companies are exported to Japan. See for example, the Korean newspaper articles below.

> As Germinated brown rice becomes well-known as a healthy food, various brands of GBR and GBR-related appliances are coming to the market. *Cuckoo Homesys* sells "Bal-a-hyeon-mi-bab-sot [GBR rice cooker]" which sprouts brown rice before it starts cooking. *Woong-jin Cuchen* also sells a pressure cooker with an 'active brown rice' making function. *Samsung electronics* sells a refrigerator with a room for germinating brown rice, called "Welbing Sikpum Jejosil [a room to prepare healthy food]" (Yoon, 2006).

> Goo, Ja Shin, CEO of Cuckoo Homesys said, "We started exporting 'the cuckoo GBR cooker' to Japan this March and have already sold more than 5000 cookers. Thanks to the 'well-being trend', GBR is popular in Japan and so is our GBRice cooker" (Lee, 2004).

I previously mentioned the history of brown rice as lower-grade food. Around the 1980s, brown rice started to be regarded as a healthy food due to its large amounts of fiber. A later finding, this time mediated by neuroscience and molecular biology, was added in the 1990s—that sprouting of brown rice by soaking it in the water increases the amount of GABA—and came to influence multi-sited actors including food scientists, the mass media, and consumers. In Chapter 3, I mainly analyzed the interactive practices of food scientists and the media mainly, while focusing on the construction of a scientific thought style to connect natural foods and molecular bioactive components. In this chapter, I mainly analyze through what processes Korean consumers interact with diverse actors around GBR as functional foods. In the first section of this chapter, I explicate how biomedical scientists and health agencies construct everyday habits as a site where individual consumers take the responsibility of constant health management. In the latter section, I examine how Korean female consumers are transformed while interacting with the mass media, popularized bioscientific knowledge, GABA, GBR, GBR-related domestic technologies and on-line communication technologies.

2. Self-management of Everyday Life

The global tendency to construct everyday habits as an important site of health management was noted in Chapter 1. Such tendencies are also found in the accounts of Korean biomedical scientists and governmental health agencies. On November 17, 2006, Korean Minister for Health and Welfare (Minister Yoo, Si-min) devised and declared the ten "Gukmin Am Yebang Suchik [citizens' principles for preventing cancer]" that emphasize healthy everyday lifestyle practices. Not only did the Ministry include "healthy diets," based on the ten principles, but it opened a website containing more detailed information on healthy diets. For example, broccoli is mentioned as the source of quercetin which inhibits the proliferation of brain tumors and broncogenic carcinoma. The Korean Association of Internal Medicine (Korean physicians' association) has held three annual symposia on lifestyle-related diseases in 2003, 2004 and 2005. Dr. Seon, Hee-sik (2004) made the following presentation in the second symposium.

> Diseases caused by dietary habits include, as you already know, not only metabolic diseases such as coronary artery diseases, atherosclerosis, diabetes and obesity but also some cancers such as breast cancer, distal colon cancer, prostate cancer, pancreatic cancer, ovarian cancer and endometrial cancer. (……) It is being demonstrated that taking a lot of green tea, tea, cocoa, and chocolate which contain beneficial polyphenols could prevent symptoms of aging, dementia and Parkinson's disease. According to Moon, Ok-ryun's (2000) research, the socioeconomic burden caused by obesity-related diseases in Korea reached 460 billion won (about 400 million US dollar) (Seon, 2004).

The above account is also available on the Korean Association of Internal Medicine and Dr. Seon's clinic's websites. Through those websites, both biomedical experts and the lay people interested in reducing the risks of chronic diseases are introduced to scientific information on functional foods and bioactive molecules.

Clarke et al. coined the term "biomedicalization" to indicate the transformation that American medicine has undergone through with technoscientific innovation since the late 1990s (Clarke et al., 2003). Through biomedicalization, American medicine has been tuned to theories, experimental apparatuses and techniques of molecular biology, biotechnology and genomics. According to Clarke et al., in addition to these material/practical changes in how medicine manages health, the transformation also occurred in the concept of health management held by the lay public and the experts alike. The realm of medical treatment expanded from the direct control over acute/epidemic disease control into the *management* of chronic disease. Subsequently, proper management of chronic illnesses has become *individual* moral responsibility, which must be fulfilled through constant self-education, self-surveillance and risk assessment. The new term, "biomedicalization" indicates such complicated changes occurring simultaneously in material, practical and conceptual realms. In other words, since around the beginning of the new millennium, everyday habits have been biomedicalized through the practices of high-tech biomedicine and the moral discourses of individual health management. The above examples from Korean Ministry for Health and Welfare and the symposium held by the Korean Association of Internal Medicine reveal that Korean biomedical experts and governments are participating in biomedicalizinh chronic symptoms as "lifestyle-related disease" and some natural foods as sources of molecular bioactive components.

Several other analytical frameworks are available to examine such simultaneous transformation. The simultaneous construction of bioscientific knowledge and discourse to frame individual and collective meaningful behaviors is addressed as "biosociality" by Rabinow (1992). In biosociality, the formation of new social groups, politics, economies and cultures is mediated by technoscientific knowledge, language and practice that attempt to understand the nature of human body. Functional foods work as a nexus of a particular biosociality, where the production of bioscientific information and the food-consumers concerned about lifestyle-related disease are connected. The concern over lifestyle-related diseases embodies both political and technoscientific dimensions. The increasing interest of individuals in managing the invisible but imminent health risks is situated in a condition where much politics is performed in the name of the "well-being" of the population; simultaneously, how people perceive and react to risks is mediated by technoscience.

In his analyses on molecular genetics, Rose also demonstrates that technologies enabling visualization of the molecular-level changes in the biomedical-human bodies reconstruct the meaning of "social" lifestyles and produce "somatic individualities" (Novas & Rose, 2000; Rabinow & Rose, 2006; Rose, 2001, 2003, 2006). For example, whilst biomedical experts attempt to explain the susceptibility to breast cancer with the genetic mutations in genes, women with BRCA1/2 mutations lobby for more research funding for genomics, perform prospective mastectomy, and organize self-help groups. In other words, biomedical knowledge *reforms* the patients' life. Patients' collective individualities are newly assembled on the somatic understanding of their bodies and conditions in order for them to share information of molecular genetics and/or related concerns. As such "somatic individualities" are constituted, languages, thought styles and practices around somatic molecules spread out from the esoteric circles of the biomedical experts to the lay public (Novas & Rose, 2000). The public, as well as the experts, come to value the acts of reforming and improving human bodies with the aids of bioscientific knowledge and practices. The common trait between the technology producing somatic individualities and the one producing functional foods are clearly in their capacity to provide the lay public with the ability to understand and act upon bioscientific information, and in pointing out what is (worth) to be seen in the natural object—be it a human body or rice.

What has not been analyzed sufficiently through empirical observation is how the mass media participates in biomedicalization of everyday habits in the new millennium. Bioscientific knowledge produced by food scientists, however, is not usually conveyed to the lay public directly. News press, magazines and advertisements come to play an increasingly important role in relaying biomedical discourses in a form that can is more readily interpreted by the lay public. The new information on GBR to (prospective) consumers of functional foods combined with concerns over lifestyle-related diseases is also spelled out by multiple media sources.

> Rice is good for health. In particular, if you germinate brown rice, the level of gamma aminobutyric acid, often called GABA increases in brown rice. It is reported that rats with high blood pressure showed a marked decrease in their blood pressure after eating GABA-increased rice (Ha, 2006).
>
> The cholesterol-lowering mechanism of GBR was found out. A food company, FANCL in Japan has conducted research to prove the health-benefit of GBR. The recent research used rats with high-cholesterol and demonstrated that GBR makes cholesterol excreted (Han, 2006).
>
> Germinated food can cure your "modern disease" (*Hyundae-byung*) such as obesity and cancer. Various diseases come from instant, carnivorous and high-calorie diets. Germinated foods are natural and healthy. In particular, [germinated] brown rice is good for improving memory as it facilitates the metabolism of neuronal cells (Park & Chung, 2006).

The above media texts construct GBR as a functional food which can reduce the risks of lifestyle-related diseases. As I discussed in Chapter 3, there remain some uncertainties with regards to the connection between GABA, GBR, and lifestyle-related diseases. Food scientists' accounts in peer-reviewed journals tend to make careful statements as they are well aware of difficulties in providing a definite proof to link specific health benefits and complex mixtures of chemicals—foods. However, with all the uncertainties, a new readiness to positively perceive bioactive molecules from foods has been constructed. My argument in Chapter 3 was that the so-called popularized scientific knowledge plays an important role in constructing such readiness with vivid images—be it the connection between natural whole foods and molecular bioactive components or between dietary habits and lifestyle-related disease as seen in the above quotes—provided for core experts, scientists in related fields and the lay public. In other words, the media participates to “close the black box” of functional food-related research not simply through streamlining research findings, but through actively constructing a thought style for food scientists to focus on molecular-level research (Latour, 1987).

Then, what do the media do in relation to consumers? What kind of readiness is constructed through the interaction between the media accounts and consumers? I will start by examining the advertisement of a GBR cooker (see Figure 13).

First, the advertisements of the GBR cooker work again to construct a particular readiness to perceive GABA from rice. The cooker advertisements closely connect consumers’ interests in healthy lifestyles that can be practiced everyday to technoscience, as it emphasizes that the cooker can set up the optimal sprouting condition (in terms of temperature and pH) to maximize the amount of GABA increased. With the cooker in their kitchens, the GBR-GABA-health connection comes to consumers’ life with only one-touch of a button and can be practiced regularly. In constructing this new form of domestic lives added by a new technological artifact (cooker), media languages perform and translate the information of GABA as well as advertise the rice cooker. This spread-out bioscientific information of GABA comes to work as the “obligatory passage point” in the marketing of GBR-as-a-functional-food by the rice cooker company (Callon, 1986; Latour, 1987, 1988).

Yet previous literatures have noted that the performance of the mass media narratives does not stop at repeating scientists’ knowledge. The media has produced their own ways of telling what consumers can obtain from biomedicalization *and* commercialization of various diagnostic processes (Casper & Clarke, 1998; Rose, 2003). Often, the media’s narratives of biomedicalization are heterogeneous and are not limited to the summary of scientific information (Karpf, 1988). We can find practices to produce a particular narrative of biomedicalization in the mass media reports on GBR as well.

> The town Oe-sam-po in Kangwon Province was awarded as the best town for “environmental-friendly agriculture” in 2006. This town makes germinated brown rice using certified environmentally-friendly rice. As the town provides their GBR to Asiana Airline, the town acts as the leader of environmentally-friendly agriculture and marketing (Han, 2006).

The above quotes from a Korean newspaper reveal the media's roles in conveying the message that GBR is a natural and/or environmentally-friendly form of food. In scientific sense, rice does not have to be grown by environmental-friendly agricultural methods to be become enriched with healthy bioactive components. In fact, some scientific journal accounts attempt to construct the meaning of functional foods which include genetically modified foods or foods developed by other technoscientific techniques as long as they have health benefits demonstrated in scientific experimental settings (Brower, 1998, 2005; Swinbanks & O'Brien, 1993). However, the images (see Figure 14) of nature connected to GBR by the mass media enables the image of environmentally-friendliness, "organic," and natural to *converge* within the frame of GBR as a product of bioscientific research. Through the convergence, biomedicalization of foods is combined with post-industrial consumers' readiness to consume "natural" foods for health benefits.

Another media narrative of biomedicalization involves "ethical" notions. Again advertisements play an important role in complicating the processes of biomedicalization with complex cultural signs. See, for example, the below excerpts from magazine articles below.

> Since we have to cook rice everyday anyway (*I-wang-i-myeon Mae-il Cha-ri-neun Bab-sang-e*), let's prepare the right (*Je-dae-ro Ji-un*; directly translated as "properly cooked") rice. Germinated Brown Rice contains 10 times more GABA than white rice, 2.5 times than brown rice. GABA, a kind of an amino acid, prevents high blood pressure and calms down the nervous system to relive the stress and anxiety. GBR is particularly good for obese people, students preparing for the entrance exam (*su-hum-saeng*), and stressed people. 7:3 or 5:5 composition of white rice and GBR are most delicious. Using an electronic rice cooker with a function for mixed-grain can help your cooking (Kim, 2004).[42]

As discussed before, ethical language used by health officials promoting functional foods provide an umbrella under which everyday lifestyle management, risk management of modern foods (which are related to over-production, distribution, consumption and lifestyle-related diseases), and the necessity to understand natural foods through sound bio-technoscience can all converge. Yet the above articles and similar accounts need separate analyses—whilst directly targeting the lay audiences reading women's magazines, they combine all new strategies of *health management* and *commercial* products such as GBR-cookers into one vivid image. The

[42] The article was published in a Korean magazine 'Woman Sense', which targets mainly housewives in their 30s and 40s.

consumers are not supposed to just buy GBR. They are educated to appreciate the value of GBR by its large amount of GABA. Also they are expected to see the green images of seaweeds or soybeans as matching side-dishes for GBR and interpret the symbolic meaning of "nature" in risk society as something that can now be wedded to bioscientific information.

The mass media's roles go even further than constructing connections between health management and market. From the above magazine article, we see that marketing of GBR in Korea is extended to eliciting Korean mothers' particular ethics, their sense of responsibility for their "*Suheomsaeng* (students preparing for the college entrance test)" kids. The East Asian economic boom from 60s to 80s led to a large number of women who received high-level education. In Korea, the pressure for women to get jobs and become professional increased greatly since 1980s. However, as Cho noted, most of the educated women could not find their place in the limited job markets, especially after the 90s' financial crisis, and had to stay at home like their mothers (Cho, 2002). In such circumstances, it was not a coincidence that Korean mothers who competitively and passionately devote their energy into their kids' English education appeared in 1990s (Park & Abelmann, 2004). Cho (2002) noted changes in Korean society after the 1990s as the combination of consumerism and the re-construction of "home" by young women: "The job market has not expanded to meet young women's high aspirations for employment, a situation compounded by the financial crisis of 1997. In such a gloomy situation, young women attempt to secure their own space and new resources for power. [……] They try to make the family home a site of self-realization through consumption." (Cho, 2002, p. 187)

In 1990s' Korea with its advanced capitalism, the household has become something housewives re-construct as a place where they reach their professional potential by being a professional at housekeeping. The ethical dimension of GBR added by the media cleverly appeals to Korean housewives' interpretation of not just health risks but also households situated in their historical and cultural context (see Figure 15).

3. Consumers' Actions Online

The interests of GBR or rice-cooker industries in profit-making, however, experience unexpected friction as the marketing appeals to professionals at housekeeping, a generation of modern wives who received education and enjoyed culture of consumerism. It is suggested by some magazine articles that health-concerned and budget-minded housewives should germinate brown rice for themselves instead of buying pre-germinated brown rice in a package or using expensive kitchen appliances.

> Germinated brown rice improves the brain's activity to increase learning and memory. (……) We can purchase [pre-made] GBR from markets but it is expensive. *How about making GBR at home? It is not difficult to make and we can also adjust the length of germs as we want.* The method of preparing GBR is as following ("U-ri bab-sang ji-ki-neun geon-gang pa-su-kkun hyeon-mi: Jib-e-seo bal-a-hyeon-mi man-deul-gi [Brown rice, the guardian of our meal: How to make GBR at home]," 2006).

The above article featured in a popular women's magazine *Yeoseong Donga* has been hyperlinked to more than 5000 personal blogs in Korea.[43] The following directions in this article for making GBR state that "fresh, dehulled not before six months, organic" brown rice and "clean spring water" should be used to prepare GBR. If some brown rice is seen to float over the water during washing, the floating grains should be removed so that those "not fully grown brown rice which easily go rotten would not harm" other brown rice. The next step is soaking. The amount of time for soaking varies among magazine articles—yet the above article recommends eight to ten hours in 30 degree Celsius water; it is suggested that in winter the process should be performed in warm places. After the recommended period of soaking, now the sprouts start to come out of the germs. The article says, "if your water shows bubbles and milky color, it means that the germination has begun. Remove water from the germinating brown rice and place the rice on the bamboo strainer covered with cotton towel. Place a bigger bowl under the bamboo strainer and pour water from time to time. Again the frequency of the water pouring varies among different articles but the general suggestion is two to four times a day. When the length of the sprout looks good—usually, meaning one to two millimeter—the germination process is complete".

Through tracking the hyperlinks, which visibly showed me the path through which a GBR story propagates, I could follow how media articles travel into educated and health-concerned

[43] Search with "make GBR for yourself at home" in http://blog.naver.com/ (one of the main blog-network in South Korea) showed 5,130 blogs featuring hyperlinks to several popular media articles explaining the processes of making GBR at home. For textual analyses below, I selected some of those blogs which show typical patterns of presenting media articles with the bloggers' own comments and/or pictures.

Korean female consumers' personal places—their blogs. In consumers' personal blogs, I observed various interactions between blogging consumers and the above or similar magazine/news articles. In several cases, it was observed that consumers followed the DIY protocol of making GBR presented by those news/magazine articles carefully. In one blog, a woman writes that she tried repeating the GBR making procedures for herself because "pre-made GBR is too expensive to buy and my husband has sensitive intestines for regular brown rice." Yet not only did she hyperlink the magazine article featuring the protocols of making GBR at home to her own blog, she also wrote another article for herself with the pictures that she took while making GBR.

See Figure 16 from one Korean housewife's blog. Starting from the picture of a paper on which GBR-making protocols are written, and then the picture showing all the materials and apparatuses needed, the blogger presents her GBR-making procedures using detailed visual images and texts. She paraphrases and emphasizes the rule "never use tap water or boiled water! They do not have enough amount of oxygen needed for germination." Her pictures reveal all the details of GBR-making procedures step-by-step and she identifies herself as the one who takes care of her husband's health with her knowledge. The blog, thus, becomes a place where multiple practices are performed to construct a functional food network. Through blogging, the consumer starts to be connected to magazine articles that convey multi-layered messages of the proper consumption of functional food, re-articulates the messages as a form embedded in her own practices and reflection, *and* expresses her new identity explicitly as knowledgeable health manger for the family.

In another blog, a woman with a 27 month-old baby lists what she thinks is good for mothers to do for their babies. She writes that she "is proud that she fed breast-milk, used cotton diaper" and made "cookies and ice cream for herself at home" and so on. On the top of her list is making GBR as a healthy food for her baby.

> Because [pre-manufactured] GBR is too expensive, I buy brown rice and make GBR for myself. It is much easier and simpler than I expected. The price of GBR and of regular brown rice is too different. *You really should make GBR for yourselves if you have not so far*. Just rinse brown rice several times and soak it in clean water. Place soaked rice in shaded areas and [pour] water two or three times a day. Within two days, you can see it germinate.

Besides repeating the media messages encouraging them to be budget-minded and germinate brown rice for themselves, the consumers also contemplate also speak to each other and express their understanding of risk, functional foods and their responsibility.

> My husband suddenly got a health-problem. (……) It turned out that my husband had a bit of gastric ulcer. I was terrified. (……) So I read many books and learned that white rice is so bad. White rice is rice without germs, rice with all the nutrients pilled-off. So it's merely an empty shell made by rice-pilling industry. *I hear that it is all proven*—white rice makes so many kinds of diseases including high blood pressure, diabetes and lipid liver [as white rice lacks important nutrients]. *I think it is so stupid if people keep eating white rice and spending their money for modern food-processing industries, just because it is hard to change their habits.* My husband no more complains about his habitual stomachache. He even says he likes my rice more than his mother's white rice.

> *We should eat brown rice [meaning GBR here] with the responsibility that it is the alternative to our time [modernity].* I can understand that we can easily be seduced into white rice. It is easier to cook and tastes less coarse. However, making GBR-eating a habit [a mode of life] is the best place to hideaway from the environmental pollution existing everywhere in our [modern] time. We face all the hazards from instant foods, air pollution and environmental hormones. The way to protect our body is eating GBR. [……] Knowledge makes GBR more delicious!

> I was an ordinary housewife who did not have time to read books. I used to be depressed because I also had dreams and ambitions when I was young. Yet I got out of my depression and changed my thought after I read this book [about GBR and other functional foods]. I became to thought: if domestic labor (*sal-lim*) is my job anyway, I will do it right!
> Before reading this book, I used to cook just anything my husband and kids liked. It was out of such ignorance. "Meals at risk" really referred to my cooking. [……] I don't think I am a helpless housewife who can't do anything [important] but domestic labor anymore. I am proud of myself who can explain why these foods that I prepared are good for bodies. Now I think that everyone can become a housewife but not everyone can become a knowledgeable housewife. Think about it; if I can make my son have a habit of healthy eating, it will decrease his susceptibility to diabetes, cardiovascular diseases and high blood pressure in the future. I will, by all means, become a knowledgeable mother for my son. We housewives should all become knowledgeable! If we become knowledgeable, our husbands and kids become healthy!

By inscribing their reflection and desires on on-line spaces, the consumers engender more than echoes of the conventional media's educational languages. They signify and express what ethical modes of living mean through blogging, a technological medium for multi-directional communication. It is observed that in relation to functional food consumers' on-line conversation, on-line connection between the consumers and the food industry is also re-constituted to fit better for bi-directional communication than uni-directional informing or advertisements. For example, blogs rather than company webpages are used increasingly by functional food companies in Korea. Park Nam-ju, senior managing director in CJ said in his interview with *Stock Daily* in 2005,

> Taking care of [physical] well-being [of the family] is now becoming the everyday practices of housewives (*Jubu*). Our company opened a blog in an attempt to inform those knowledgeable and demanding Jubu better with more detailed information on our Tofu products (Kim, 2005).[44]

It is also observed that housewives produce local knowledge of making GBR and make it widely available through blogging. For example, questions such as "should I really use the bottled spring water even though it is expensive?" or "how does the bubbles and murky water really look when the germination begins?" are asked and answered by their texts and images. Some of the questions brought up include experimental ideas such as "if I buy GBR, instead of regular brown rice, and use the GBR-making function of a GBR cooker, could that maximize the nutritional component in rice?" or "how much should the time for soaking be increased in winter?"—which in some cases lead to actual experimental practices in their kitchens and further sharing of the results on-line. As the blogger's practical know-how of how to adapt to the real situations in making GBR at home accumulated, the kitchen becomes her laboratory. She performs experimental trials in her own contexts. Her blog is constructed as a lab note recording and showing the procedures to other people who want to repeat her practice. As her own blog articles are hyperlinked by other bloggers, her texts, images, voices, coordinating styles reach other consumers in their intimate environments.

The bloggers' on-line relationship with media sources conveying translated messages of GBR and GABA and also within consumers themselves indicate a newly emerging biosociality and, in a more political sense, biopower (Rabinow, 1992; Rabinow & Rose, 2006). In biopower, "individual are brought to work on themselves, under certain forms of authority, in relation to truth discourses, by means of practices of the self, in the name of individual or collective life or health" (Rabinow & Rose, 2006, p. 9). While constructing the network of GBR, the consumers

[44] This particular Tofu product contains more GABA than the conventional Tofu because it is made of germinated soy beans.

come to work on themselves in relation to heterogeneous discourses of health-management which involve authority of scientific-knowledge but also the convergence of nature, knowledge and ethics. Importantly, the transformation of themselves into the individual agent of biopower involves the transformation of their domestic environments. Through a GBR consumer's writing and communication on the blog, she transforms her kitchen from a personal space into a relational place for the interaction with a functional food, bioscientific information, and communicative interactions with other housewives.

On one hand, transformation of housewives into the productive agent of "biopower" is not a new phenomenon in East Asian history. Around the late 19th century, producing healthy husbands and kids who can work for the "modernizing" Japanese military and industry became the responsibility of housewives in Japan and later, in the colonial empire. The catchphrase, "good wife and wise mother (*ryosai kenbo*, 良妻賢母)" or "wise mother and good wife (*hyeon-mo yang-cheo*, 賢母良妻)", is still used widely in Japan and in Korea (Cho, 2002; Kurotani, 2006; Park & Liao, 2000; Smith, 2000; Tamanoi, 1991). The catchphrases encouraged housewives to properly manage the families' physical and mental health by staying at home, preparing good meals, and providing emotional supports. Some GBR cooker advertisements ("be a good mother," "because I love my family," and the images mothers preparing foods) certainly echo the ideals of "wise mother and good wife" (see Figure 17).

However, the GBR consumers' reconstruction of their kitchens into a lab in the on-line network and transformation of cooking into an experiment is not a simple repetition of "wise mother and good wife", the old biopower working in the Japanese colonial era. Above all, it needs to be noted that we could not predict in advance that the kitchen connected to blogs will be an actor to distribute the images of mothers preparing healthy food. Yoon's (2000, p. 346) research reveal that Korean housewives were not included in the information society before the turn of the new millennium. In a survey performed in 1999, the percentage of Korean housewives using "computers" was 10.9 percent—the percentage of housewives using the internet was not even calculated. In-depth interviews with housewives revealed remarks such as "I feel uncomfortable with lagging behind the time. Yet because I just can't [have good computer skills], I give up," or "I don't use a computer but I urge my kids to use it not to get behind." The interviewees were middle-class and highly-educated housewives living in a Silicon Valley-type innovation cluster in Korea. Before 2000, it was natural to assume that common housewives do not have access to computer-mediated communication. Yet, blogging housewives or kitchens linked to blogs emerged suddenly and made remarkable growth. In 2006, LG Economic Research Institute coined a new term “wife-logger” in a report and stated that about 280,000 blogging housewives have formed a noticeable social group in Korea (Son, 2006). According to the research, 3,180,000 housewives or about 59 percent of all the Korean housewives without paid employment are light- or heavy-users of blogs.

Those wife-loggers are what Cho (2002) noted as young women who “attempt to secure their own space and new resources for power.” They are educated consumers after the financial crisis “try[ing] to make the family home a site of self-realization through consumption.” The processes through which those wife-loggers are brought to work on themselves and their family members are different from the processes through which Korean housewives in the early twentieth century was encouraged to work for the health of the population in Japanese empire. Wife-loggers construct a new meaning of “wise mother and good wife” while negotiating their identities as professionals at housekeeping and as health-managers to decrease the burden of lifestyle-related diseases. After all, they “have to cook rice everyday anyway” and “domestic labor is [their] job anyway.” While they negotiate the mode of doing their job “right”, the meaning of “wise mother and good wife” is creatively appropriated and combined with popularized bioscientific knowledge on functional foods, strategies to manage health risks in everyday life, and blogs linking kitchens. Like the network of *Ryosai Kenbo* in Japanese colonial times raising the healthy soldiers, the GBR network is also “under certain authorities, in relation to truth discourses, by means of practices of the self, in the name of individual or collective life or health” (Rabinow & Rose, 2006, p. 9). Yet the practices of Korean housewives to negotiate their identities cannot be generalized as simply another form of biopower working.[45]

The particularity of biopower introducing GBR consumers to everyday health management in can be found in the characteristics of “diseases” as well. The available truth discourse stating that “germinated food can cure your modern disease (*Hyundae-byung*) such as obesity and cancer” (Park & Chung, 2006) and “the socioeconomic burden caused by obesity-related

[45] Several Japanese advertisements of GABA-based food products I watched emphasize images of healthy individuals but not good mothers. Although I cannot make general remarks based on some advertisements that I watched, this strengthening of *ryosai kenbo* combined with the perceived health risks of lifestyle-related diseases seems to be Korean-specific phenomena. More research on the identities of *ryosai kenbo* in contemporary Japan and in Korea will reveal their differences and social contingencies.

diseases in Korea reached 460 billion won" (Seon, 2004) does not just appeal to people who have cancer or obesity-related diseases. Such truth discourses can be related even to housewives with perfectly normal family members since they are always at risk to increase the probability of developing lifestyle-related diseases if their everyday habits are not carefully managed. The will to intervene in dietary habits can work in its most preventative and regular mode through the notion of lifestyle-related disease. To this already "regular" mode of health management, Korean wife-loggers add their regular consumption of GBR and blogs as means of communication domesticated in their regular settings.[46] In other words, the biosociality of GBR is particular in a sense that it is mediated by high-tech biomedical studies in molecular levels yet simultaneously incorporates most ordinary sites and practices—such as eating, cooking, kitchens and blogs (see Figure 18).

The food scientists' knowledge claims on GBR-GABA are connected to Korean female consumers through long chains of translations—lifestyle-related diseases, advertisement, images of nature, magazine articles telling them to become a responsible and knowledgeable mother. In these long chains of translations, scientific claims, what is understood as nature, the professional housewives with their knowledge and blogging all "hang together" and form an "interactively stabilized" connection between technoscience and society (Pickering, 2005b). And even when Korean housewives' seemingly act as the simple consumers who do not ask questions about technoscience of GABA, GBR or GBR-related electronic gadgets, their actions are more than passing along the black-box as a complete set of technoscientific construction. The Korean housewives communicate, produce local knowledge, appropriate and reconstitute gendering discourses to become the actor of the functional food network working as a new biosociality.

4. Summary

What we see in the case study of GBR-as-a-functional-food are interrelated transformations that occurring on the multiple levels. Brown rice was transformed materially via germination. Bioscientific information of GABA produced by scientists was transformed discursively via media's hybridization of technoscienfic information and natural values of GBR. The

[46] See Cowan (1983) and Wajcman (2000) for the mutual construction of technology, domestic labor and gender identities. To their STS-analysis of technology in domestic settings, my study adds new media technology as an important actor.

advertisement of GBR by the media had to appeal to Korean housewives' interests in "becoming a professional at housekeeping" in addition to informing them of GBR as agro-industrial products. Ethical languages used for GBR, in its heterogeneous relations, goes much further than repeating scientists' finding of bioactive components in a functional food. The media hybridize the values of understanding biotechnoscientific information, consuming "natural" foods, behaving as responsible housewives all together and construct an unexpected assemblage around the functional food developed by bioscientists. Here blogs get involved in the functional food network starting as a mediator between journalism and the audience. Also blogs mediate Korean female consumers' expression of their practices of local expertise and notions around their ethics of "we should become knowledgeable housewives and mothers." It is not my argument that Korean consumers of GBR commonly share the monolithic ideals of "knowledgeable housewives and mothers." Rather, I argue that abstract ideals are *transformed* through blogging as something that is narrated by housewives, combined with words and images of their experiments, and hypertextually connected to other blogging housewives. The powerful connection between GBR as a functional food and the consuming subject as "professionals at housework" becomes strengthened as an outcome of all those transformation.

The processes of co-producing lifestyle-related diseases and functional-food consumption include the expansion of biotechnoscience from the experts to the public and to foods consumed in everyday lives. However, this is not a linear or monolithic process. Rather, while the will to biomedicalize lifestyle-related diseases and foods spreads, multiple sites—FAO conference in UN, health officials' reports, news articles, magazine articles, advertising images, Korean housewives' kitchens and their blogs—are revealed as the place where heterogeneous actors intervene and produce complicated assemblages diverging from the linear scientification of foods. We find transformation on multiple levels—including materials (rice, GABA, kitchen), practices (cooking, blogging) and stories (what needs to be seen in brown rice, what "wise mother and good wife" mean). GBR as a functional food, thus, is a socio-techno-scientific network that produces and is shaped by dynamic actors in multiple locales. Food scientists' experimental findings, mass media discourses of "lifestyle-related diseases" and proper lifestyles, and Korean female consumers who interpret and distribute values of functional foods signified in their gendered circumstances form an assemblage, from which the relationship among technoscience, foods, and Korean female consumers as the gendered agents of biosociality are constituted and reconstituted.

CHAPTER 5
CONCLUSION

Over the course of this dissertation, I have described how through functional foods, food risks are connected to broader issues, including reflexive modernization, molecularized thought style and the moral responsibility of individuals to manage their lifestyle-related diseases narrated by the mass media and consumers themselves. Functional foods, including GBR, are the result of multiple layers of reconstruction that goes on in the late industrialized society. In Chapter 1, I reviewed previous literature on foods generally regarded as healthy to argue that foods with clinically demonstrated health benefits have not yet been analyzed sufficiently. In Chapter 2, I revealed that functional foods emerge as an ambiguous category while people are affected by new health policies focusing on the health risks of chronic diseases and molecular understanding of natural whole foods. In Chapter 3 and 4, I demonstrated that the mass media, food scientists, and Korean housewives interactively construct the readiness to connect health benefits, responsible individuals and molecular bioactive components through GBR.

While employing the analytical frameworks of actor-network theory (ANT) and posthumanist approach, this dissertation explicated multiple actors and processes constructing new links between technoscience, the media, foods, and consumers engaged in a type of "reflexive" consumption. Reflexive consumption of GBR as a functional food is not caused directly by scientific findings about GBR and GABA; it is not caused directly by the media interest in making sensational headlines of GBR as a magic bullet either. Rather, the power of functional foods in the late industrial society is an outcome of heterogeneous actors' performance, which, in successful cases, constitutes long human-material-conceptual chains of translation. Along the chains of translation, food scientists' interest in neurotransmitter is connected to the media's simplified accounts on GBR's health benefits; mothers' interest in managing their families' health, and the "webs" of kitchens connected through online communication. Importantly, no such concepts as "original" interest of food scientists, the media, or consumers could be maintained as stable entities while the network of food scientists, the media, and consumers is formed around functional foods and their bioactive components. I demonstrated that new (or re-newed) sense of responsibilities, modes of using blogs and stylized ways of scientific thought all emerged as a result of the actors' performance and subsequent transformation. As a conclusion, in this chapter, I will discuss theoretical issues—risk, molecular understanding of life forms, and posthumanist approach. I will also clarify further in what sense that the functional food network reveals the situation where the boundaries between (1) natural and artificial, (2) the core experts and the generally educated, (3) biomedical realm and everyday have become reconstructed noticeably since the late 1990s.

1. Dietary Intervention as a New Type of Risk Management

It is generally noted that in an advanced industrialized society, there is an increasing anxiety about health and ecological risks (Beck, 1992; Lupton, 1993; Giddens, 1999; Beck-Gernsheim, 2000). Beck (1992) explained the new paradigm of "late modernity" or "reflexive modernization" coming after early industrialization as the condition where "questions of the development and employment of technologies are being eclipsed by questions of the political and economic 'management' of the risks of actually or potentially utilized technologies" (p. 19). Beck's statement indicates that in reflexive modernity, people come to demand not just productivity obtained through technological development but also strategies to handle risks, the side effects of modern progress.

Although it is less frequently analyzed than BSE (bovine serum encephalopathy), GM-food, food contamination, and ecological disasters in the risk-related literature, the "diseases of civilization" is also a site mentioned at least once by Beck to observe the "newer risks" in late modernity (Beck, 1992, p. 27). Yet, there seem to be certain differences between the diseases of civilization (which are caused by generally unhealthy habits such as low-fiber diets or sedentary lifestyles) and the formerly mentioned food-related risks (which are caused by definable "risky" agents) regarding the methods of intervention. The strategy to manage risks of diabetes through dietary intervention is different from the strategy, for instance, to manage BSE-related health risks by keeping SRM (specified risk materials) out of the human food chains. While the latter type of risk is controlled mainly by state-level projects, the former is managed by individual citizens' or consumers' constant attention to enhancing their health, combined with state-led projects.

How, then, can we use the general notion of "risk society" to analyze particular forms of new risks called the "diseases of civilization" or non-communicable diseases (NCDs)? Does dietary intervention into NCDs constitute a new mode of risk management in reflexive modernity? In what sense is this risk management different from more traditional (or "modern") biomedical projects—such as pharmaceutical or hygienic treatments of epidemic diseases? To what extent can the notion of "the second age of the modernity" be employed to understand the difference between the 21st century's and earlier times' health concerns and strategies for management of those concerns (Beck, 2000)? Given that there was no time when people were living free of health-related risk factors, in what sense has (or will) our modernity become "reflexive"? How does early modernity differ from reflexive modernity in terms of its risk—is there a qualitative or quantitative difference?

Approximately since the late 1990s, a tendency to manage health risks through the reform of mundane practices such as diet and exercise has emerged. The idea that diseases can be prevented through the reform of everyday habits, however, is not a new notion in itself. The early 20th century was already mentioned as a golden age for disease prevention through behavioral change in Starr's (1982) historical account. In the early 20th century, the maintenance of the public health was disconnected from the early health reformers of the 19th century with moralism and subsequently connected to at that time prospering "clinics." Clinics as biotechno-scientific institutes took the role of educating individuals to develop healthy habits—such as child care, personal hygienic practice and diets. For instance, in the 1900s-1920s, more than three million school children in the US were enlisted by antituberculosis clinics as "modern health crusaders" who "performed 'hygienic chores', such as brushing their teeth" (Starr, 1982, p. 191). The importance of getting regular health examination was also emphasized during the World War I, since the draft physicals, which showed that about 47 percent of the 3,760,000 men examined had some physical impairment, strengthened the social conviction that many Americans were in fact not "healthy and normal" (Starr, 1982, p. 193). Thus, it is hard to argue that people in the early 21st century are more informed or more anxious about the health risks caused by noxious lifestyles than people in the early 20th century.

Yet, certain differences can be observed between public health management described by Starr and the growing interests in managing NCDs. For example, the excerpts from two reports below reveal the particular characteristics of health management since the late 1990s.

> Even though detailed information on the size of functional food market is relatively sparse depending on how the category is defined, one thing that all studies seem to agree on is that functional markets grow steadily each year, with annual growth rate estimates varying between 8% and 14%. This trend is likely to continue as changing population demographics (e.g. an ageing population) and the effects of lifestyle diseases create greater demand for food products targeting health and wellness (Food and Agriculture Organization of the United Nations [FAO], 2007, p. 4).

> A Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases met in Geneva from 28 January to 1 February 2002. The meeting was opened by Dr D. Yach, Executive Director, Noncommunicable Diseases (NCDs) and Mental Health, WHO, on behalf of the Directors-General of the Food and Agriculture Organization of the United Nations and the World Health Organization. (……) The Consultation recognized that the growing epidemic of chronic disease afflicting both developed and developing countries was related to dietary and lifestyle changes (……). Chronic NCDs—including obesity, diabetes mellitus, cardiovascular disease (CVD), hypertension and stroke, and some types of cancer --- are becoming increasingly significant causes of disability and premature death in both developing and newly developed countries, placing additional burdens on already overtaxed national health budgets (WHO, 2003, p. 54).

From the above-mentioned reports, it seems evident that the main problem of public health has shifted from communicable diseases to non-communicable diseases. By definition, a communicable disease is an infectious disease that can be transmitted from one individual to another. Thus, the primary goal for health education and medical examination was to confine and cure "the people who are ill" (Starr, 1982, p. 181). On the contrary, the spread of non-communicable diseases such as diabetes or stroke cannot be prevented by separating the infected people from the healthy ones. Even a perfectly isolated individual can be in danger of developing a chronic illness if he or she has an unhealthy lifestyle. This seemingly practical difference is connected to the distinctive characteristic of contemporary biotechnology noted by Rose (2006). According to Rose, technologies of life after the end of the 20th century seek *optimization* rather than normalization. The goals and practices of life sciences are "no longer constrained by the poles of health and illness" but aim to "secure the best possible future for those who are their subjects" (Rose, 2006, p. 6). See the following excerpts from the WHO report.

> In the 1970s, it was thought that risks were not significantly increased after certain late ages and that there would be no benefit in changing habits, such as dietary habits, after 80 years old as there was no epidemiological evidence that changing habits would affect mortality or even health conditions among older people. There was also a feeling that people ‘‘earned’’ some unhealthy behaviors simply because of reaching "old age". (……)

> More recently, older people have been encouraged to eat a healthy diet --- as large and as varied as possible while maintaining their weight --- and particularly to continue exercise. Liu et al. have reported an observed risk of atherosclerotic disease among older women that was approximately 30% less in women who ate 5-10 servings of fruits and vegetables per day than in those who ate 2-5 servings per day. It seems that, as elderly patients have a higher cardiovascular risk, they are more likely to gain from risk factor modification (WHO, 2003, p. 40).

Here, the aim of the dietary intervention was not to cure or confine the person with illnesses. Rather, "5-10 servings of fruits and vegetables per day" were claimed to reduce the risks of atherosclerotic disease more than "2-5 servings" could do. In other words, the dietary intervention attempted to *improve the probability* of reducing the risks of atherosclerosis. Unlike *normality* which can be clearly defined by the absence of "abnormalities" such as bacterial, viral, or parasitic agents in the bodies, the *improved* status cannot be defined as a concrete entity. One can always attempt to *further improve* the probability of resisting against the risks of non-communicable diseases even in a situation where one cannot cure NCDs. This focus on improvement rather than cure is precisely one of the stated goals of chronic-diseases-related research performed by biomedical scientists. According to the WHO report, "beyond the appropriate medical treatment for those already affected, the public health approach of primary prevention is considered to be the most cost-effective, affordable and sustainable course of action to cope with the chronic disease epidemic worldwide" (WHO, 2003, p. 5). Thus, in the health governance of NCDs after the late 1990s, we can clearly see the prestigious biomedical communities' interest in studying and intervening in mundane habits—something as mundane as eating apples. On the contrary, biomedical communities in the early 20th century struggled to relegate prevention to a less prestigious status than medical/pharmaceutical cure. After the introduction of antibiotics, advice about hygiene and diets provided by health clinics was "banished from medical care" (Starr, 1982, p. 197). Public health management through promoting healthy everyday habits became only a secondary fragment of the US medical system.

Let me go back to the issue of "risk." How does health risk in modernity differ from risk in late/reflexive modernity, given that people in the age of early modernization also were aware of or concerned about risks caused by unhealthy habits? In answering that question, it may be important to carefully examine Latour's (2003, p. 36) response to Beck.

> 'reflexive' is not to be taken for 'reflexivity', as if people in the time of remodernization were more 'aware' or 'conscious' than at earlier periods. Quite the opposite: 'reflexive' means, in my reading of it, that the unintended consequences of actions reverberate throughout the whole of society in such a way that they have become intractable. (…..) As to 'risk', it does not mean that we run more dangers than before, but that we are now entangled, whereas the modernist dream was to disentangle us from the morass of the past.

In Starr's (1982) historical account of the early 20th century, there were specific sites—clinics, the health centers, and governmental health programs—where the health risks of tuberculosis and venereal diseases were calculated and managed. Public health reformers established health education and diagnostic services as their own realm of expertise. This realm of public health reform was severed from social welfare, which had encompassed a broader realm inhabited by the 19th-century public health reformers with their moralism. More importantly, the realm of public health was also separated from more "scientific" clinical medicine, which was inhabited by the medical doctors trying to draw the clear line between health education and medical practices. One example of public health reform campaigns working separately with the mainstream biomedical communities can be found in the promotion of the low-calorie regimen. When high-calorie diets were villainized in the late 1970s the driving-force mainly came from the popular media but *not* from health-related institutes. The historical trend of separating medical cure and dietary health care continued in the US (Guthman, 2003).

We can see that the line between medical care and dietary advice becomes much more blurred in the "Joint WHO/FAO Expert Consultation on Diet, Nutrition, and the Prevention of Chronic Diseases" published in the beginning of the 21st century. The joint undertaking of food-related clinical research by food scientists and medical scientists suggested that neither of the two groups claim the monopoly over the legitimate understanding of NCDs or healthy foods. In addition, their 160-page report revealed the complexity of managing the risks of NCDs through dietary interventions. Regular consumption of healthy foods does not "cure" NCDs. Still, it is considered as the most sustainable solution as it reduces the possibility of developing NCDs.

Certainly, the idea to manage NCDs through dietary intervention is subject to criticism. There is little explanation for variations in dietary response among individuals except for short accounts on preliminary gene-nutrient interaction studies. It is difficult to measure the impact of a healthy nutrient when it is combined with hundreds of other nutrients in dietary foodstuffs and environmental surroundings. However, with all the uncertainties remaining with the incomplete calculation of relative amount of risk caused by unhealthy diets, a new perception of lifestyle-related diseases is emerging to influence both scientists and the lay public. The situation is markedly different from the 1960s when people knew that high blood cholesterol might be the sign of unhealthiness and even one of the main risk factors to cause "diseases of civilization." Villainizing high-calorie diets at that time without definite scientific proof was regarded as "food faddism" spread by the lay public and the mass media (Garrety, 1997). On the contrary, from the WHO report (2003), we can see that not just the compartmentalized realm of public health or the discreditable popular media but biomedical experts also participate in spreading the perception that the productivity of modern food industrialization has brought health risks as unintended consequences. People who are interested in lowering the risks of obesity or hypertension come to be entangled in both high-tech biomedical research and popular lay discourses of healthy eating (such as, eat your fruits and vegetables). In this sense, risks of lifestyle-related diseases and dietary intervention constitute a distinctively "late modern" phenomenon. Late modern risks, according to Latour (2003, p. 36), designate the situation where "the unintended consequences of actions reverberate throughout the whole of society in such a way that they have become *intractable*."

Why is it important to pay attention to Latour's interpretation of risks as entanglement? Along with several sociologists, I think Beck's discussion puts too much emphasis on the *destructive* attribute of risk originating from the *inherent* side effect of industrialization (Atkinson, 2007; Elliott, 2002; Tulloch & Lupton 2002; Latour, 2003). From Beck's perspective, risk society "is not an option" because it is brought by the "reality" of risks which "dominate the thinking and behaviour of human beings and institutions" and eventually reveal "the self-evident truths of industrial society" that its mechanism of progress is utterly unsustainable (Beck, 1996, p. 184). The cutting-edge development of "the chemical industry, reactor technology, microelectronics, and genetic technology" is considered as the fundamentals of modernity and simultaneously, a driving force of reflexive modernization in which hazards produced "call into question—indeed abolish—the basis of industrial society" (Beck, 1996, p. 184).[47] Yet Beck's accounts of *overall* social transformation, which the *reality* of risks coming from modern industry is supposed to bring out, are not supported by empirical examination of actual peoples and institutes coping with risks. Though it seems reasonable to argue that the inherent reality of

[47] See also Beck, Giddens, and Lash (1994) for discussion of reflexive modernization.

the Chernobyl reactor incident led many people to question the sustainability of nuclear power generation, Jasanoff and Kim's (2009) analysis revealed that there is much room for discussion over social variations in terms of the risk-perception and risk-management strategies for nuclear power in different local contexts. Tulloch and Lupton (2002) also criticized Beck's "tendency to generalize about people's attitudes to risk without founding his contentions on empirical evidence" (p. 366) and provided their findings that educated consumers enjoyed forming identities as "consumers of science" while they responded to the perceived risks of GM foods. According to Tulloch and Lupton, "a citizenship based on affect, pleasure and the 'buzz of risk' consumption" (p. 366) is also an important feature of risk society. The above studies, I think, reveal more than the expected gap between grand theoretical remarks and everyday conditions. The studies suggest that although the phenomena of reflexive modernity can be analyzed with the notion of risk, the notion itself needs to be expanded to plural frameworks that are not limited to the social transformation premised on fear of real catastrophe.

From my empirical analysis of functional foods, I find Latour's (2003) translation of "risk" into network or "a maze of unexpected associations between heterogeneous elements" most useful in analyzing the features of late modern health risks of lifestyle-related diseases (p. 36). As I mentioned in the previous chapters, the term lifestyle-related diseases is replacing elderly diseases or diseases of civilization in Japanese, Korean, and European biomedical and/or regulatory organizations—*maladie de comportement* is used in French Ministry of Health, "生活習慣病" in Japanese Ministry of Health, Labor, and Welfare, lifestyle-related disease in the UK and "Saeng-hwal-seub-gwan-byeong [everyday habit disease]" in Korean Physicians' Association. Such transitions reflect more than changes in names. Rather, the changes indicate the *perceptual transformation* which biomedical communities go through. Mundane habits are now recognized as risk factors whose impacts can be calculated (albeit incompletely) in credible bioscientific research institutes such as WHO and national health agencies. Simultaneously, some natural foods go through *relational transformation*. The early modern channels through which natural foods were connected to technoscience included food additives, genetic modification, nutrient isolation, and preservation techniques, all of which resulted in the *industrialization* of foods. With the advent of lifestyle-related diseases, finding bioactive components from natural food sources constitutes a new channel through which natural foods can be connected to technoscience. In this new type of connection between natural foods and technoscience, natural foods can retain their form of and marketing appeal as minimally processed whole foods. See the below excerpts from the FAO report (2007, pp. 3-4).

> Currently, there is no universally accepted term for functional foods. (……) However, functional foods are generally considered as those foods which are intended to be consumed as *part of the normal diet and that contain biologically active components* which offer the potential of enhanced health or reduced risk of disease. Examples of functional foods include foods that contain specific minerals, vitamins, fatty acids or dietary fibre, foods with added biologically active substances such as phytochemicals or other antioxidants and probiotics that have live beneficial. According to this definition, *unmodified whole foods such as fruits and vegetables represent the simplest form* of a functional food. For example, broccoli, carrots, or tomatoes would be considered functional foods because they are rich in such physiologically active components as sulforaphane, beta carotene, and lycopene, respectively (emphasis added).

Throughout the dissertation, I examined the processes through which "unmodified whole foods" are transformed into functional foods with clinically demonstrated health benefits. I employed GBR among many unmodified functional foods to examine a particular case where natural foods are connected to biomedical research while retaining their form of whole foods. My research showed that in food scientists' laboratory, the rice genes responsible for increased amount of GABA after sprouting were sequenced and deposited into the Genebank maintained by the US National Center for Biology Information (NCBI). Meanwhile, the popular media's discursive techniques connected GBR and GABA to images of nature and Korean mothers' sense of responsibility. Importantly, Korean housewives did not passively play the role of responsible mothers-consumers as inscribed by the media. Rather, they actively circulated their lay knowledge of germinating brown rice and transformed their kitchens as an unconventional place connected to scientific information and bloggers. Korean housewives also produced their own discourses that their domestic labor is important for the health management of family members. Through the practices of food scientists, the mass media, and Korean housewives, brown rice has been transformed from rice with coarse tastes and textures into a functional food for reducing the risk of lifestyle-related diseases.

The story of GBR as a functional food demonstrates that risks can be understood as unexpected associations rather than the systematic side effects of modernity caused by the reality of technoscience. Focusing on the characteristics of risks as the systematic side effects, Beck emphasized the subversive potential of technoscientific risks. However, the perceived risks of lifestyle-related diseases (supposedly) caused by unhealthy eating habits, as I examined, did not lead to the "collapse" of the established scientific mode of risk calculation as Beck argued (1992, p. 22). Rather, the risk perception was accompanied by new thought styles of food scientists employing the notions and apparatuses of neuroscience and molecular biology. The perception of industrialized food risks also did not constitute general anxiety performing as "a very shaky foundation for political movements" that could upset the modern capitalist economic development (Beck, 1992, p. 49). Compared with ecological disasters caused by the modern industry, the risk of lifestyle-related diseases is connected less to political movement than to consumption, new biotechnoscience to molecularize foods, and on-line assembly of health-concerned consumers. This phenomenon, at first, will seem to indicate the lack of sociologically significant meaning in the assemblages formed around the perceived risks of lifestyle-related diseases. The assemblages around functional foods seem to feature less politically reflexive capacity compared with the ones around the socially expressed risks of GM foods, for instance (Schurman, 2004). Yet, I argue that despite the seeming absence of political meaning, such associations mediated through functional foods and risks of lifestyle-related diseases are led to more fundamental transformation in terms of the meaning of life.

To make my own comments on what fundamental transformation pertaining to the meaning of life is occurring in late modernity, I will first borrow some of Rose's arguments on contemporary biomedicine. According to Rose (2006), the contemporary biomedical body such as embryos used in pre-implementation genetic diagnosis (PGD) is different from the body understood and intervened by eugenics, no matter how much PGD and eugenics might seem similar under the general framework of discrimination on genetic grounds. In the PGD case, bioscientific intervention does not "condemn a defective or inferior person to death" but instead "embodies the hope" that high-tech biomedicine can equip future parents to optimize their chance of having a healthy baby (Rose, 2006, p. 51). Eugenics programs aim to maximize the health and fitness of population for competitions between nation-states. On the contrary, the contemporary biomedicine does not work to improve the health of the national population as an organic whole. Rose gave a brief sketch of Chinese population policy going through transformation. The country's well-known Marriage Laws between the 1950s and 1980s explicitly pinpointed categories of people inappropriate for reproduction based on partners' family history of hereditary or mental disease. However, after debates in 2002 and 2003, the law was amended into a new State Family Planning and Population Commission which repealed compulsory medical inspection before marriage. Shortly before the reform, the Chinese Human Genome Ethical, Legal, and Social Implications Committee issued a statement in 2000 claiming that human genomics research should concentrate not on eugenics but on disease prevention and treatment.

The contrasts made by Rose did not aim to suggest that if contraception is "voluntary" or performed with "informed consents," then it leaves no room for criticizing political projects of controlling the population. Nor did the contrasts attest that the new way of population control is more humane than eugenics. The point, as I interpret, is simply that we cannot analyze new practices of health management with the old framework of state-led eugenics. We need a new critical framework. Rose argued that the difference between eugenics and the contemporary reproductive technology is not limited to their stated goals but is related to the different politics of the two societies. Eugenics was a tool of sovereign plans for national population. On the contrary, the PGD consultation by genetic counselors is an episode of an ethopolitics, where individuals employ diverse self-techniques to "judge and act upon themselves to make themselves better than they are" (Rose, 2006, p. 27). For example, PGD consultations manifest that (potential) parents are *responsible* for their family members' health and they *should* work to optimize the probability of producing healthy babies. In the age of PGD, parents are active participants in understanding and improving their reproductive behaviors in terms of new bioscientific languages.

I will begin my own commentary here. I agree with Rose that less coercive yet no less significant types of health risk management are emerging and they need new analytical approaches. I also think it is important to analyze how the emergence of a new social form such as "ethopolitics" is connected to new biomedicine in its actual practices such as the PGD technology understood by future parents. Yet, my study on GBR as a functional food reveals three important features which Rose has not examined in relation to biomedicine in the 21st century. In short, I think Rose's dual emphasis on the social responsibility to act on bodies (termed "ethopolitics" or "somatization of ethics") and human individuality understood as fundamentally corporeal existence by bioscientific knowledge (termed "somatic individuality") limits his analysis in terms of accounting for broader changes occurring simultaneously in the human and nonhuman domains. Below, I will explain the three important changes covered throughout my dissertation.

2. New Thought Styles to Understand Foods and Everyday Life

First, the GBR story demonstrates that not just understanding of human beings such as corporeal existence but also bioscientific understanding of nonhuman entities such as rice can mediate the connection between the intense sense of responsibilities to act on bodies and new social grouping. Here "understanding" indicates more than scientific language to describe how increased GABA in GBR works in the human brain—otherwise, understanding of food would merely be a means to understanding of human bodies. The processes through which functional foods come to be understood in bioscientific language include multi-sited activities and transformation, which I examined under the framework of "thought styles," constructed collectively by the mass media and food scientists.

Both the media and food scientists played active roles in placing molecular bioactive components in the functional-food-chronic-disease network. In Chapter 3, I employed Fleck's (p. 109) terms, "thought style," "esoteric circles," and "exoteric circles" to analyze how food scientists and the media are engaged in bi-directional relationship in knowledge production. Fleck argued that a certain sort of moral force works during the processes of scientific knowledge production and enables scientists to have faith in the ideal of knowledge. Most of the food scientists I interviewed or analyzed through their published research expressed that the evidence to connect one bioactive molecule to health benefits of a functional food is insufficient, inconclusive, or debatable. In particular, food scientists' research articles on GBR often state that the goal to explain the health benefits of GBR by GABA has not yet been achieved. However, food scientists also had certain faith that focus on molecules in foods rather than in macronutrients would make their research more significant; and would eventually better elucidate the relationship between foods and health. The connection between molecular bioactive components, functional foods, and lifestyle-related diseases can thus be seen as food scientists' ideal of knowledge. Despite limitations in pursuing functional foods research through bioactive molecules, food scientists' actual practices were strongly directed toward strengthening the GBR-GABA connection and, subsequently, toward tuning food science more closely to the literature, experimental apparatuses, and techniques of molecular bioscience and neuropharmacology. Such changes in the food scientists' domain are connected to particular historical and social transformation—I have described this transformation with the story of Tong-il rice contrasted against GBR.

In Chapter 3, I also described how news articles and advertisements employed GABA to make the claim that GBR has health benefits that are scientifically proven. Sketchy overviews of results and social implication of scientific research while omitting details are often pointed out as the inherent limitation of scientific journalism. In the case of functional foods, the media are blamed by food scientists for their interests in portraying "magic bullets" rather than relaying more correct information, including the fact that some results are inconclusive. It is not difficult to find what is omitted in the mass media accounts of GBR compared with published research articles. Apparently, newspaper articles and advertisements need to be shorter than research articles as they are supposed to be read by the lay public, which has more interest in direct applicability of the research outcomes rather than in academic contexts. However, even a quick review of Korean media coverage of functional foods reveals that not all media accounts are interested in introducing functional foods as a quick solution to lifestyle-related diseases. Some reporters expressed concerns over the disproportionately large amount of governmental support to functional foods compared with other "cutting-edge" biotechnoscience such as genomics or pharmaceutical development (Hong, 2005). In addition, my analysis of scientists' accounts of GBR and GABA in various contexts—in their research articles, review articles, the mass media, and interviews—revealed that simplification of scientific knowledge is actually not exclusively done by the mass media. The tendencies or "thought style" to connect molecular bioactive components (such as GABA) closely to functional foods (such as GBR) even with remaining ambiguities were expressed by food scientists as well. In cases when core experts employed simplified accounts, such accounts worked as faith in the ideal of knowledge or as tools to present their research to audiences who are not directly involved in functional foods research.

I did not make the argument that there is no difference between scientific knowledge produced by experts' experiments and science news covered in popular magazines. Yet, through my analysis of media accounts and food scientists' accounts, I argued that both esoteric and exoteric circles are involved in producing simplified accounts of scientific knowledge during the construction of a thought style. In particular, I demonstrated that a thought style binds actors in a thought community by examining the controversy over the BBB and ways some Korean news and the US media handle the issue. According to some US media which repeated neuroscientist Leventhal's statement, GABA in the form of a food component cannot cross the BBB and thus cannot result in health benefits. This BBB controversy is, however, not as simple as the media in the US portray it. Some research by food scientists demonstrates that a small amount of GABA can cross BBB or GABA can work in the peripheral neurons that are not blocked by BBB. Many food scientists still perform their research on the assumption that GABA in GBR exerts physiological benefits in human bodies. Notably although the BBB controversy remains as an on-going debate, neither the Korean nor the US media features the controversy with sufficient scientific details. Instead, the media tend to relay brief accounts made by neuroscientists ("GABA itself does not pass through the blood brain barrier, so eating it will be of little value") or food scientists. By so doing, the Korean media has strengthened the connection between GABA and GBR despite remaining ambiguities. Meanwhile, the US media strengthened the connection between pharmaceutical science and GABA.

To say the least, understanding of rice in bioscientific terms needs more than core bioscientific experts' findings on how bioactive molecules work in human bodies. The processes through which functional foods come to be understood in bioscientific language included the *production* of a new thought style through the interactions between the media and food scientists. The different ways the media in the US and in Korea covers the BBB controversy differently reveals that knowledge on functional foods and bioactive components are not simply "found" by food scientists and "streamlined" by the media. Through the contact between the media and food scientists, a stylized way to see GBR along with GABA and lifestyle-related diseases emerged, and the thought style provoked further actions to strengthen the connection. The processes to construct molecular bioactive components in foods and their bioactivities as the objects of food scientists' investigation cannot be interpreted as a mere expansion of the molecular understanding of human bodies into foods (Rose, 2006). My study is the first to demonstrate that the interactive performance of food scientists and the mass-media was crucial in constructing "new forms of molecular life, and ……. a new way of understanding life itself" (Rose, 2006, p. 109) in the realm of health management since the late 1990s.

With my findings on GBR, I also argued that the line between normal and abnormal becomes blurred with the genetic notion of susceptibility and the social goal of health optimization is not enough for analyzing the biomedicalization of everyday lifestyles in the 21st century. Rose covered the concepts of "(reducing the risks of) susceptibility," "enhancement," and "optimization" with the examples of genetic diagnosis, psychopharmaceutical drugs, and amniocentesis. Through those biomedical technologies, we come to have the perception that (1) that some people are more "susceptible" to certain disease such as breast cancer or depression, (2) their susceptibility can be diagnosed through genetic- or molecular-level detection technologies, and (3) the susceptibility can be reduced by biomedical interventions mainly in the form of drugs; hence, susceptible individuals can aim to enhance or optimize their health status. As Rose (p. 83) argued, the "susceptible" is indeed an ambiguous concept that does not belong to the status of being normal or abnormal. Still, new clinical interventions such as pre-implementation genetic diagnosis (PGD) or selective serotonin reuptake inhibitor (SSRI) aim to intervene into the bodies of people whose health status is *less than normal*. In relation to that sub-normality, all the above-mentioned modes of interventions still remain in the "clinical" settings; there are differences in terms of scales between "smart drugs," which target a single type of neuroreceptor, and early-generation anxiolytics, which affect broad brain regions. Although individuals sharing the understanding of genetic/molecular susceptibility *act on* themselves in Rose's cases, their practices as somatic individuals still take place in biomedical institutes and within the settings separating the normal and the sub-normal.

On the contrary, my story of GBR consumed to lower the risks of several chronic disease demonstrates that with molecular understanding of foods, people who are *normal* and are in their *everyday settings* also come to participate in constructing a new mode of health governance in the 21st century. In other words, the site to form social groups with individuals acting on themselves to improve their health status comes to be extended from clinics to everyday practices such as food consumption, domestic work, kitchen appliances, and blogging. In Chapter 4, I demonstrated that chronic diseases have become the major focus of health regulation in Korea as in the West. Simultaneously, improving dietary habits has come to be regarded as the major factor in reducing the risk of lifestyle-related diseases—such as hypertension, diabetes, obesity and mental irritation, all of which are noted to increase greatly with "modernization" in Korea. Chronic and non-communicable symptoms, which used to be called adult diseases (*seong-in-byeong*), are increasingly referred to by the Korean media as lifestyle-related diseases (*saeng-hwal-seub-gwan-byeong*) or modern diseases (*hyeon-dae-byeong*). It is generally remarked that Korean consumers' demands for healthy lifestyle and concerns over industrialization have formed "well-being as social trends" in Korea since the late 1990s. The English word "well-being" (*wel-bing*) is often used by Koreans to indicate healthy lifestyles. "Do well-being" (*wel-bing-ha-da*) is used as a marketing catchphrase for healthy foods, yoga classes, and various "green" products with less harmful chemicals. Phrases such as "hot fever of well-being" (*wel-bing yeol-pung*) or "well-being trend" (*wel-bing-tu-ren-du*) are usually employed to describe the extensive commoditization of healthy lifestyles (Kim & Heo, 2005). In many newspaper articles and governmental reports, the "well-being trend" is recognized as an obviously noticeable social force in Korea in the new millennium. The sense of responsibility to manage everyday lives for health is superimposed upon this consumer culture epitomized as "hot fever of well-being."

In Chapter 4, I described how extra-scientific agents such as news media, magazine articles, and advertisements play an active role in constructing the new mode of health maintenance in everyday lives. Employing Rabinow's (1992) concept of biosociality, I demonstrated that bioscientific information and its translation by the media produce an assembly where the food-consuming subjects are placed in relation to new knowledge, social groups, politics, and culture. Information on health benefits of GBR and GABA, as it meets the media accounts of Korean consumers' turn to natural foods in the age of "wel-bing-tren-du" and "saeng-hwal-seub-gwan-byeong," transforms lay consumers into managers of healthy lifestyles. In this assembly, functional foods and related products work as a nexus to bind heterogeneous humans and nonhumans together. Also through the expansion of functional foods, biomedicalization of everyday habits occurs, and consumers are enrolled in a network of lifestyle-related diseases.

In Chapter 4, I also noted that a particular type of ethical reflection works in the Korean GBR network. The particular ethics of "mothers as managers," as I see it, leads Korean housewives to work on themselves, to practice certain techniques and to relate themselves to certain forms of knowledge and moral authority. Popular media describe consumption of GBR as a moral responsibility for "mothers." The ethical dimension of GBR added by the media appeals to Korean housewives' interpretation of households situated in their specific historical and cultural context as well as in the notion of risk society. Within the moral order of self-management (*cha-ki kwan-ri*) in neoliberal society, Korean household has become something housewives re-construct as a place where they reach their professional potential by being "a professional at housekeeping" (Cho, 2002; Song, 2007). The ethical dimension of GBR, added by the media, appeals to Korean housewives' interpretation of households situated in their historical and cultural context.

3. Posthuman as an Assemblage of Humans and Nonhumans

Let me briefly go back to Rose's thesis. Rose demonstrated that the processes through which "ethopolitics" as a new social form emerges can be analyzed only by attending to the features of new biomedicine in their *actual practices* (such as the PGD technology employed by future parents) and not to the philosophical discussion over how new technology might change the traditional understanding of life/non-life, susceptible/unfit, or therapy/power. I agree with his point that empirical analysis on new biomedicine in practice is much needed to understand the particular features and problems of new social forms in the 21st century. Yet, I do not share his Weberian perspectives on "secular ethics" as the main impetus of new sociality forming around high-tech biomedicine. My dissertation shows that biosociality around GBR can be understood as an outcome of human and nonhuman actors tuned to others through open-ended processes, which cannot be summarized sufficiently by paying major attention to the "ethics" shared by the participating human actors.

In what sense is the formation of human-nonhuman assemblages around GBR an open-ended process? In Chapter 4, I demonstrated that social grouping (or biosociality) around GBR is more than the connection of *pre-existing* social groups, politics, culture and moral senses to biotechnoscience. Through the examples of GBR cookers and consumers' online communities (blogs, web forums, or web boards), I revealed that a new type of association emerged through the use of and communication about GBR and/or GBR cookers. GBR consumers' reconstruction of their kitchens into a laboratory in the online network and transformation of cooking into an experiment is not a mere repetition of old ethics summarized as "wise mother and good wife." The biosociality around GBR/GBR-cooker after the late 1990s was mediated by food scientists providing molecular understanding of foods, media combining biomedicalization with commercialization, and online communities connecting housewives' own discourses, local practices, and knowledge. In this sense, the ethics of "wise mother and good wife" was not imposed upon but rather creatively appropriated by "professionals at housekeeping" when they attempted to manage health risks of family members through GBR. To borrow, again, the interpretation of risk by Latour, the risks of lifestyle-related diseases are not to be found just in the "avoidance" of certain risky substances but rather in "a maze of unexpected associations between heterogeneous elements" (p. 36) such as GABA, rice GAD genetic sequences, the BBB controversies, cookers, advertisements, "wise mother and good wife," and blogs. To use Latour's (1987) term, housewives *enrolled* themselves into the risk-managing network of functional foods and during the enrollment, they were not only affected by the available discourses but also actively transformed themselves into knowledgeable mothers-bloggers.

Following Pickering's (1995, 2005a, 2005b) analyses of cyborg and synthetic dye history, I regard the association being formed among housewives, blogs and GABA-related scientific information as the emergence of posthuman assemblage. The word "posthuman" here does not note simply that human beings are connected to nonhuman entities to increase their capacities—otherwise, we have never been just "natural" humans, and the term "posthuman" loses its analytical strength. In the analysis of sociological/historical phenomena through the reference of posthuman assemblages, the stress is on the *performance* of nonhumans that humans cannot fully control or predict, and *vice versa*. When we consider the intersection of "social, material and conceptual heterogeneity" (Pickering, 1995, p.1) in their interactive performance and subsequent transformation, the emergence of new biosociality looks different from the variation of an "elective affinity" between ethics and capitalism that Weber (1930) noted.

I pointed out three major transformation associated with the intersection of social, material and conceptual actors around functional foods. First, changes occur in the line between core experts and exoteric amateurs as producers of scientific knowledge. Second, the line between biomedical research and dietary intervention (whose traditional has been regarded as the extension of alternative medicine [Hess, 2004]) becomes reconstructed. Third, the emerging biosociality around functional foods reshapes the conventional line between natural and artificial foods. I have already summarized the contents in Chapter 3, which deals with the construction of a thought style for functional food development, to note the changes in the line between core experts and the mass media. I also overviewed the contents in Chapter 4, which discusses transformative interactions among kitchen appliances, housewives, blogs, advertisements, and bioscientific information, to illustrate changes in the first and second boundaries. Now let me summarize the changes made in the third boundary—between natural and artificial.

In Chapter 2, by going over several cases where the boundary between natural and artificial foods becomes less certain, I argued that it is not rare to find both “natural” and “artificial” functional foods to enroll health benefits, images of nature, and molecular bioactive components as their allies to appeal to consumers. Yet, I did not present Dannon Activia—a yogurt containing modified bacteria for clinically-demonstrated health benefits—to demonstrate that there is no way for people to differentiate “natural” and “artificial” yogurt. An individual consumer might regard genetically modified rice with enriched vitamin A as clearly “artificial” and yogurt with modified bacteria as clearly “more natural than a pill.” There might be also another consumer who regards vitamin A-enriched rice with “generally-regarded-as-safe (GRAS)” labels as natural and healthy rice since it will not bear the label of genetically-modified. My argument is not that the boundary between golden rice and natural rice or between Dannon yogurt and natural yogurt cannot be drawn. Rather, I argue that the boundary is no longer something that can be commonly accepted. Some scientists, reporters, and food companies work intensively to incorporate genetically modified foods with health benefits into the category of “functional foods,” “generally regarded as safe foods,” or even “natural” foods. The use of umbrella term, “functional foods” for heterogeneous types of foods indicates that the boundary between natural and industrialized foods is becoming an object of negotiation, which will be contingently decided during the processes of food development, research, marketing, and consumption.

This argument is related to my next point in the Chapter 2. The emergence of a functional foods as natural and healthy foods cannot be examined sufficiently if we only focus on the incorporation of natural foods into food *industrialization*. The way the media translates food scientists’ experiments showing health benefits of natural foods suggest that the transformation of some natural foods into functional foods in risk society is different from the early modern/industrial appropriation of nature. Cattle raised in industrial farms are described by the media to have insufficient amount of omega-3 to prevent increased incidents of Attention Deficit and Hyperactivity Disorder. The conflict between people against food industrialization and the global food corporation to conventionalize the social movement through greenwashed products is not the main problem here. Interest in natural meat is from the beginning mediated through bioscientific research in molecular levels instead of through (industrial corporation of) pure nature. After natural foods are connected both to recent advancement in high-tech biomedicine and to individual risk management strategies while passing through molecular bioactive components (such as omega-3), the natural foods become entities different from other types of natural foods such as Belasco's "counter-cuisine," Guthman's "yuppie chow," or McMichael's "greenwash organic," which I have reviewed in Chapter 1 (Belasco, 1989; Guthman, 2003; McMichael, 2000). Consumers' interests in natural healthy foods as well as material conditions of technoscience were "tuned" during their interactions; and the unfolding of functional foods as the solution for lifestyle-related diseases can be noted as an "open-ended becoming" (Pickering, 2005b, p. 359).

4. Risk, Biomedicine, and Functional Foods

It is not the high amount of GABA, food scientists' authority, vivid images of natural and healthy foods provided by the media, or consumers' fear of health risks brought by industrialized/processed foods that alone cause the emergence of GBR as a functional food. Instead, while those heterogeneous actors—including rice, GABA, food scientists, the media, consumers, and their blogs—interact with and become tuned to others, GBR is constructed as a food that is simultaneously natural, scientific and cultural. Consumers' turn to natural foods, experiments performed by health organizations and genetic modification formed around GABA detected in rice a heterogeneous network, which from Latour's viewpoint is "a perfect translation of 'risk'" (Latour, 2003, p. 36).

The meaning of "heterogeneous" here needs careful consideration and is related to what this dissertation aims to contribute to previous sociological literature on reflexive modernity, new biomedical assemblage, and industrialization of "natural" foods. A heterogeneous network does not simply mean that we can find both human and nonhuman elements if we follow what constitutes a certain social phenomenon such as the perceived danger of processed foods or mad cow disease. Rather, the notion of a heterogeneous network where "each [element] acts as a mediator and no longer as a mere compliant intermediary" (Latour, 2003, p. 36) directs our attention to performativity and open-endedness as the important features of our living conditions constituted by the interaction of humans and nonhumans. In a so-called risk society, as several previous studies have demonstrated, more complicated things than general avoidance of industrial technoscience occur. Nonetheless, the concepts of risk society and reflexive modernity are still useful if they are employed to shed light on novel social-technical-cultural associations emerging around the new perception of what can be the most harmful to the population. This point leads to my second analytical focus. In our society, lifestyle-related diseases are considered among those with the most significant health risks. Although Rose's discussion covered new molecular-scale medicine and its intervention to reduce the susceptibility to various illnesses including lifestyle-related diseases, his discussion was focused on the emergence of new ethics to continuously work on oneself as the nucleus of new biosociality, bioeconomy and biopolitics. While I am not against pointing out this sense of responsibility for self-management as an important cultural element in the network of functional foods, I argue that it is necessary to pay more attention to the processes through which certain ethics become linkable to scientific knowledge, thought styles, the media, new communication technologies, modes of consumption, domestic technologies, and everyday practices. In the GBR case, I found that the processes of making associations involved the performative interaction between human and nonhuman elements. Their interactions were *performative* in a sense that there was no way of predicting where the perceived health risks of processed white rice consumption would be found next and form a transformative relation to. Not in an attempt to make a general account of biomedical risk management but in an attempt to provide an analytical account of what I have followed in the emerging chains of transformation, I noted the reconstruction of the three boundaries—(1) natural and artificial, (2) the core experts and the generally educated, (3) biomedical realm and everyday. Here I did not argue that the line between natural and artificial became suddenly blurred after the emergence of some natural foods produced by technoscientific means—which would include almost every kind of "natural" foods, not limited to functional foods. Rather, my study reveals the way the concepts of minimally processed, natural or healthy become all at stake *as they are connected to* particular material and social transformation occurring to multiple actors participating in the circulation of functional foods. Haraway (1992, p. 297) argued: "if organisms are natural objects, it is crucial to remember that organisms are not born; they are made in world-changing technoscientific practices by particular collective actors in particular times and places." My study on GBR shows in empirical details how nature in risk society was made by particular collective actors' technoscientific practices. By applying the combined notion of risk as a heterogeneous network and new biomedical assemblages, I demonstrated that from functional foods, we can observe more than the repeated theme in previous agro-food studies, industrialization of "natural" foods. What is constructed as "natural and healthy foods" in risk society involves the performance of heterogeneous elements including biotechnoscience and the subsequent reconstruction of conventional boundaries.

TABLES AND FIGURES

TABLE 1

Strength of evidence for functional foods currently on the U.S. market[1,2]

Functional food	Bioactive component	Health benefit	Type of evidence	Strength of evidence	Recommended amount or frequency of intake	Regulatory status
Fortified margarines	Plant sterol and stanol esters	Reduce total and LDL cholesterol	Clinical trials	Very strong	1.3 g/d for sterols 1.7 g/d for stanols	Health claim
Psyllium	Soluble fiber	Reduce total and LDL cholesterol	Clinical trials	Very strong	1 g/d	Health claim
Soy	Protein	Reduce total and LDL cholesterol	Clinical trials	Very strong	25 g/d	Health claim
Whole oat products	β-Glucan	Reduce total and LDL cholesterol	Clinical trials	Very strong	3 g/d	Health claim
Cranberry juice	Proanthocyanidins	Reduce urinary tract infections	Small number of clinical trials	Moderate	300 mL/d	Conventional food
Fatty fish	(n-3) Fatty acids	Reduce TG, reduce heart disease cardiac deaths and fatal and non-fatal myocardial infarction	Clinical trials; epidemiological studies	Strong	2/wk	Qualified health claim for dietary supplements
Garlic	Organosulfur compounds	Reduce total and LDL cholesterol	Clinical trials	Moderate	600–900 mg/d	Conventional food or dietary supplement
Green tea	Catechins	Reduce risk of certain types of cancer	Epidemiological	Weak to moderate	Unknown	Conventional food
Spinach, kale, collard greens	Lutein/zeaxanthin	Reduce risk of age-related macular degeneration	Epidemiological	Weak to moderate	6 mg/d	Conventional food or dietary supplement
Tomatoes and processed tomato products	Lycopene	Reduce risk prostate cancer	Epidemiological	Weak to moderate	Daily	Conventional food

Table 1 The above table used in Claire Hasler's (2000) article provides a list of exemplary functional foods, their molecular bioactive components, health benefits, sources of evidence that support the known health benefits (clinical trials or epidemiological data), strength of evidence acknowledged by food scientists in general, recommended amount or frequency of intake and the current regulatory status in the US market.

Categories of Functional Foods/Nutraceutical	Examples of functional foods within the category
Basic Foods	Carrots (containing the natural level of the anti-oxidant beta-carotene) Oat bran cereal (containing the natural level of beta-glucan)
Foods enhanced to have more of a functional component (via traditional breeding, special livestock feeding or genetic engineering)	Tomatoes with higher levels of lycopene (an antioxidant carotenoid) Oat bran with higher levels of beta glucan Eggs with omega-3 from flax
Isolated, purified preparations of active food ingredients (dosage form)	Isoflavones from soy omega-3 from fish oils (DHA and ALA)
Processed Foods with Added Ingredients	Calcium-enriched fruit juice

Table 2 Ministry of Agriculture and Agro-food (AAFC) in Canada provides categories of functional foods/nutraceuticals along with examples of functional foods on its website. The term "functional food" includes natural foods (such as carrots), industrialized foods (such as omega-3 extracted from fish oils) and borderline cases (such as eggs from flax-fed hens with high amount of omega-3) simultaneously (Agriculture and Agro-food in Canada, n.d.).

Table 1
Present status of "Foods for Specified Health Uses" (FOSHUs)

Functional factor	Case number	Health claim	Product
Oligosaccharides	53	Intestinal modulation	Beverages, biscuit, etc.
Lactic acid bacteria	36	*ditto*	Beverages, fermented milk
Dietary fibers	35	*ditto*	Beverages, noodle, cereal
Oligopeptides	6	Blood pressure ↓	Beverages, soup
Soybean protein	7	Serum cholesterol ↓	Sausage, hamburg
Diacyl glycerol	4	Serum triglyceride ↓	Cooking oil
Phytosterol	4	Cholestrol absorption ↓	*ditto*
Casein phosphopeptide	3	Calcium absorption ↑	Beverages, soybean curd
Tea polyphenols	3	Dental caries prevention	Beverages
Sodium alginate	3	Serum cholesterol ↓	*ditto*
Calcium salts	3	Calcium supplementation	*ditto*
Heme	2	Iron supplementation	*ditto*
Chitosan	2	Serum cholesterol ↓	Biscuit
Tochu leaf glycoside	2	Blood pressure ↓	Beverages
Sugar alcohols	2	Dental caries ↓	Sweets
Globin hydrolysate	1	Serum triglyceride ↓	Beverages
Casein dodecapeptide	1	Blood pressure ↓	*ditto*
Total	167		

Adapted from the data of the Ministry of Health and Welfare (November 22, 1999).

Table 3 In Shoichi Arai's (2000) review article "Functional Food Science in Japan: State of the Art", the table above shows FOSHUs approved in Japan by 1999 after the "fine rice." All the FOSHUs are listed with their functional factors providing specific health claim. Most health benefits provided by FOSHUs are related to preventing symptoms of aging—such as high blood pressure, high serum cholesterol, high lipid levels and osteoporosis. Arai chaired the third functional food project, "Analysis and Molecular Design of Functional Foods" between 1992 and 1995.

Partial list of functional foods and their physiologic effects

Food	Physiologic effect
Apple, barley, blackberry, blueberry, carrot, eggplant, oats, garlic, ginger, ginseng, mushroom, onion, soybean, tea	Lipid lowering
Lemon, apple, cranberry, garlic, beet, cucumber, squash, soybean, cabbage, Brussels sprouts, cauliflower, kale, broccoli, spinach	Enhanced drug detoxification
Ginseng, licorice, oats, parsley	Antiinflammatory
Cranberry, garlic, onion, green tea	Antimicrobial
Anise, fennel, soybean, cabbage	Antiestrogenic
Orange, green tea, garlic	Antiproliferative

Table 4 The above table is from John Milner's (2002) research review article "Functional foods: the US perspective" published in American Journal of Clinical Nutrition. Milner is the current chief of the Nutritional Science Research Group (NSRG) at National Cancer Institute's (NCI) Division of Cancer Prevention. Although the US legal system does not provide a regulatory term for apples with lipid lowering effect, Milner indicate that an apple can be called functional foods, rather than healthy foods, if it is "particularly beneficial in selectively altering specific physiologic processes that improve the quality of life or reduce the risk of acquiring a disease".

<Table 2> Total R&D expenditure/ratio to GDP

(Unit : thousand dollar, %)

Year	R&D Expenditure	Ratio to GDP
1970	105	0.39
1975	427	0.42
1980	2,117	0.56
1985	11,552	1.52
1990	33,499	1.87
1994	100,098	2.44
1995	121,861	2.37
1996	128,857	2.42
1997	86,107	2.48
1998	93,862	2.34
1999	104,084	2.25
2000	109,935	2.39
2001	121,488	2.59
2002	144,328	2.53
2003	159,198	2.64 p)

Note) p) means provisional

Sources: MINISTRY OF SCIENCE AND TECHNOLOGY & KOREA INSTITUTE OF SCIENCE AND TECHNOLOGY EVALUATION AND PLANNING (2004)

Table 5 Korean MOST gives statistics of total R&D expenditure and its ratio to GDP. The R&D expenditure increased dramatically in the early 1990s and then plateaued. Yet, closer examination of the R&D expenditure reveals that funding for basic science in universities and government research institutes came to be concentrated on selected projects after the late 1990s.

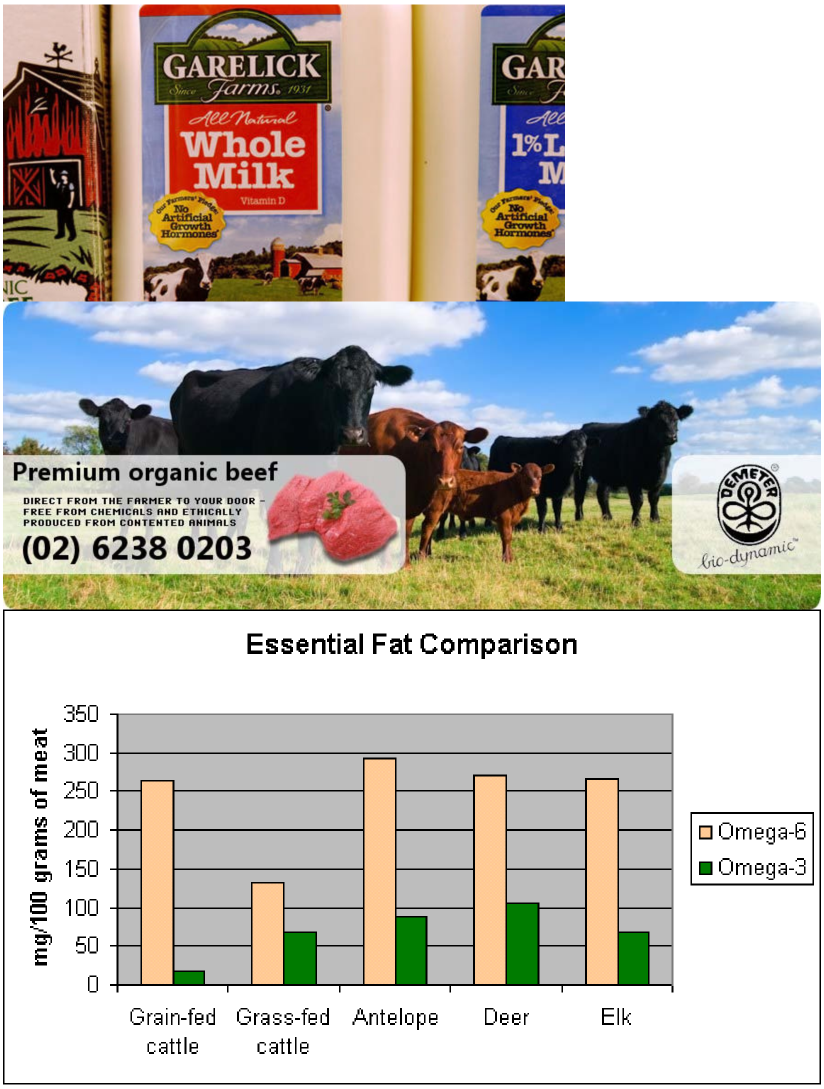


Figure 1 Above (a) The organic milk carton shows images of "clean leaving cows" as in DuPuis (2000) analysis. The carton also delivers the message that organic milk is pure, natural and healthy with the label of "no artificial growth hormone". Center (b) The image is from a corporate website run by an organic meat company. Similar to the organic milk carton, the image emphasizes clean and natural living condition of cows. Below (c) The graph is from the corporate website with the (b) image. The graph indicates that research focusing on specific nutrients (such as omega-3) and their health benefits is combined with the marketing of organic/natural functional food. While Hess (2004) sees functional food research with organic food as a type of object conflicts between the mainstream and alternative food industry, how such advertisement constructs a new network of consuming bioactive components through natural whole foods have not been analyzed. Unlike the organic milk carton in (a), the combination of the image (b) and the graph (c) works not only as cultural practices in risk society but also as new scientific information with social and economic implication.

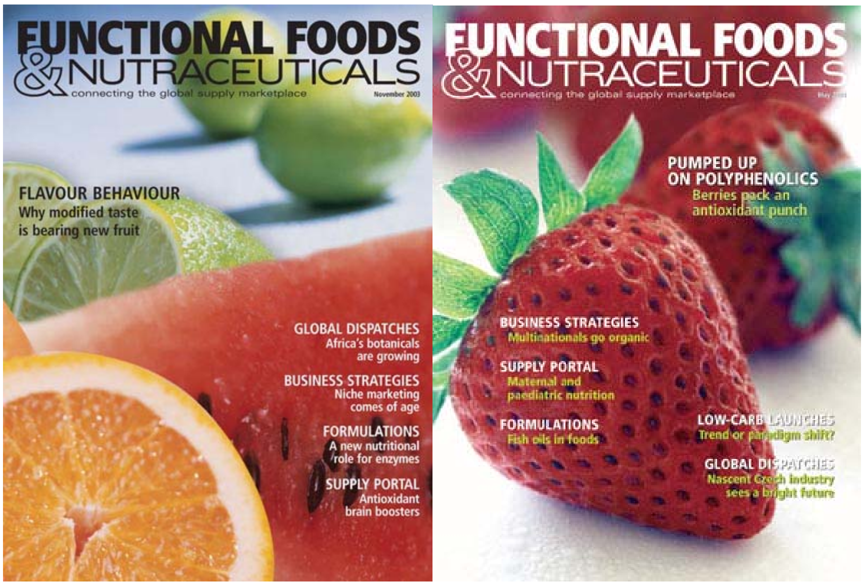


Figure 2 Pictures of foods with claimed health benefits usually emphasize the image of nature. The above two pictures from the cover of a magazine "Functional Foods and Nutraceuticals" (now changed the title into "Functional Ingredients") present the image of functional foods through color and shape of natural whole foods. The magazine covers new functional food products, scientific findings, and trends in functional food industry.

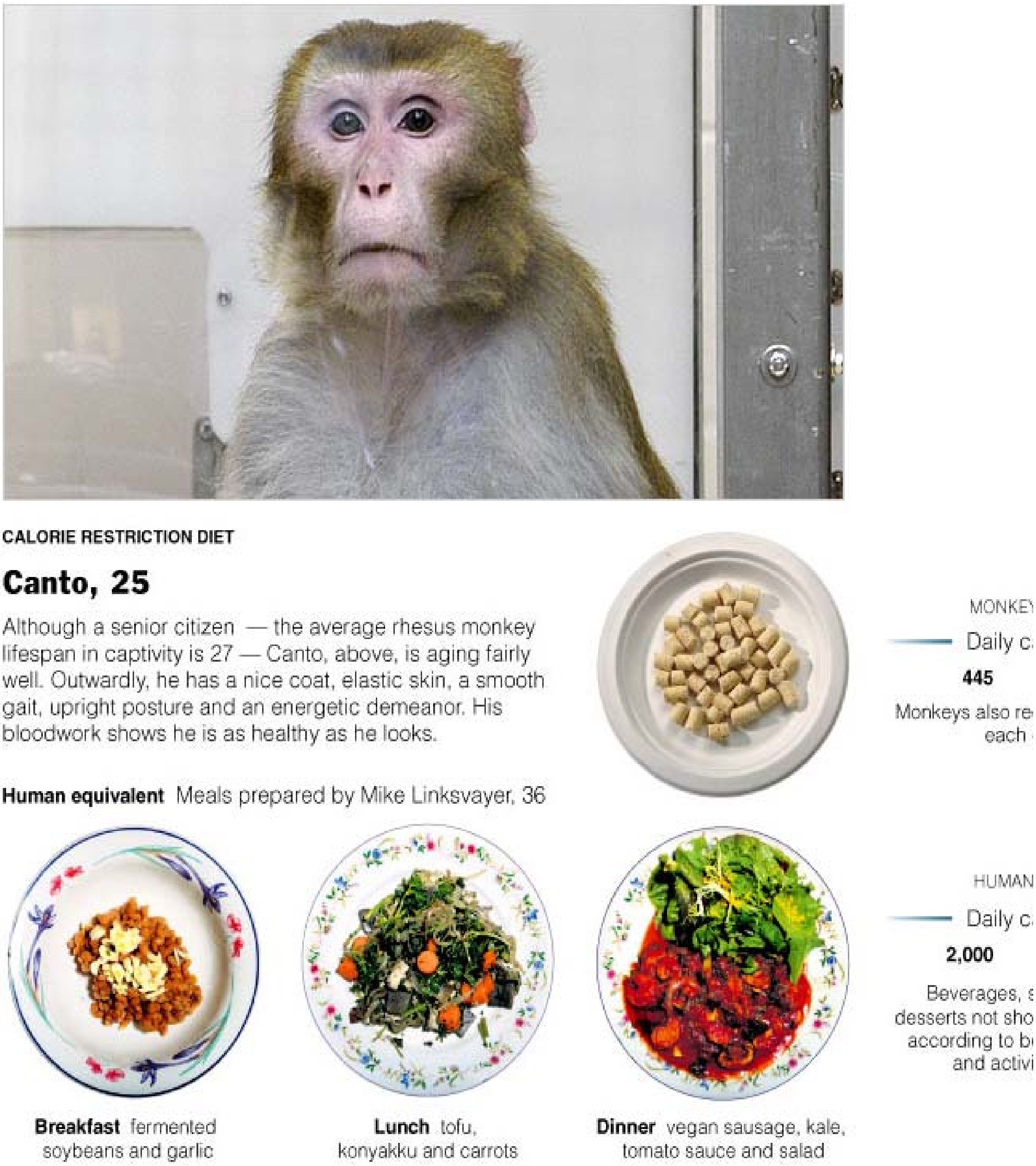


Figure 3 (cont.)

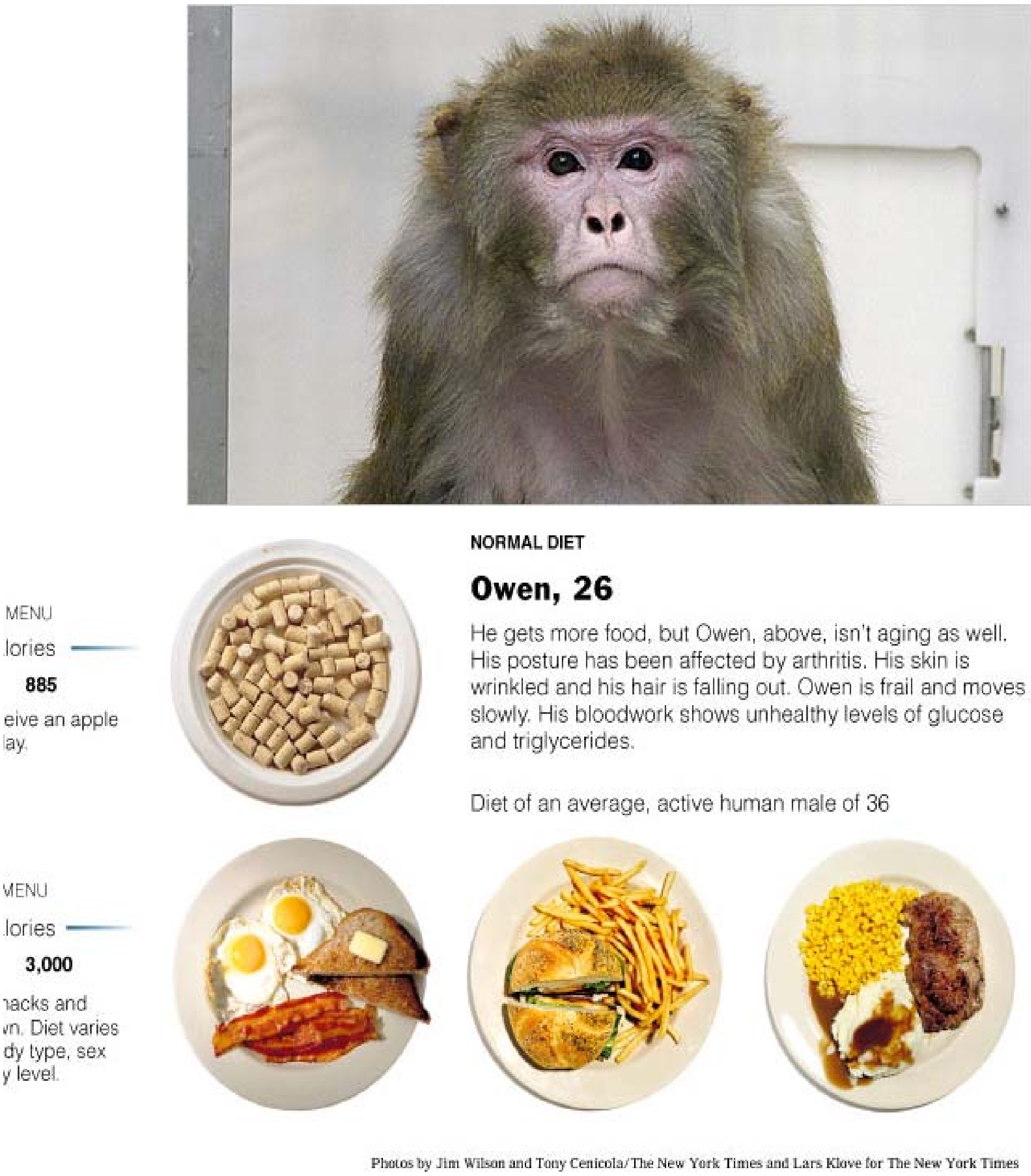


Figure 3 Pictures of two monkeys used in the experiments to assess the relationship between calorie-restriction and aging. Fewer calories is expressed as traditional Asian foods while more calorie are compared to typical fast foods presumably consumed more readily in the West.

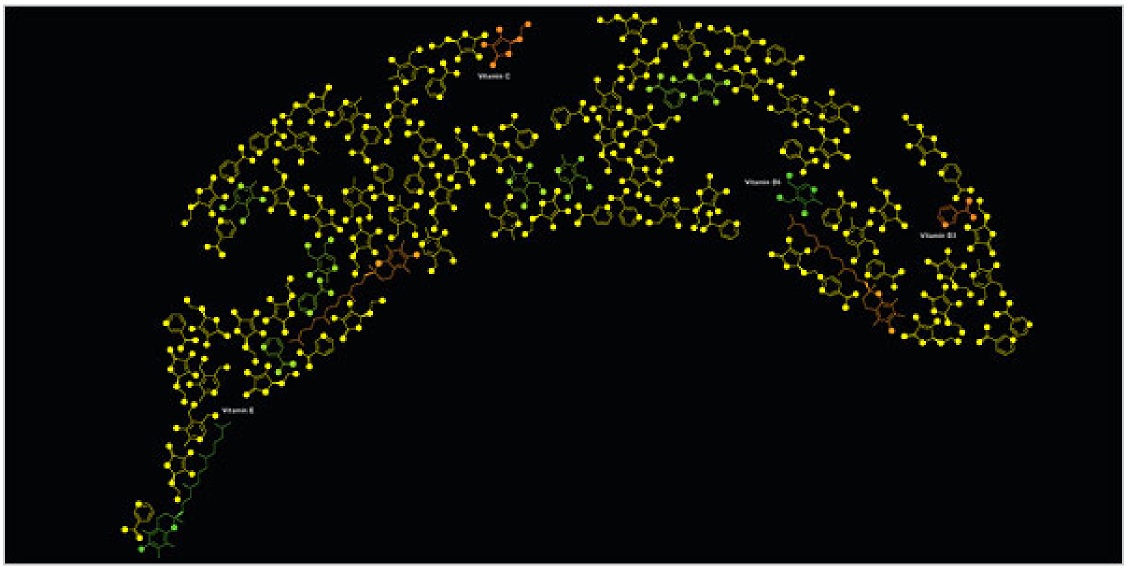


Figure 4 Theories, experiments and measuring instruments of biotechnoscience work as sensory organs for people to recognize the health benefits of natural foods through their molecular bioactive components. Meanwhile, the mass media provides images with foods and molecules to a broad range of audience. By so doing, the lay public as well as scientific audiences come to have a readiness to perceive molecules in foods. The above picture illustrated by Leo Jung was featured with Pollan's (2007) news article on food and health.

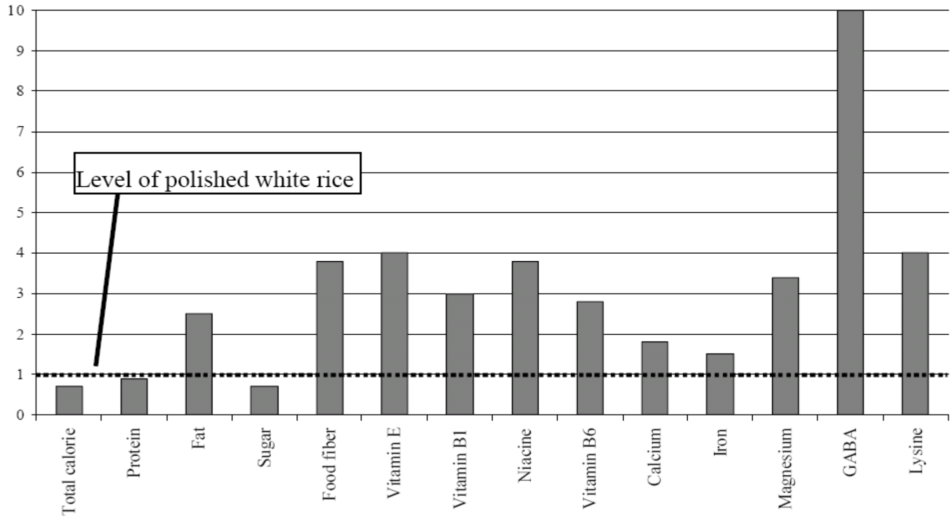
Figure 5 A new food pyramid is presented on the website of the United States Department of Agriculture (USDA) along with the pictures of whole grains. The USDA recommends eating whole grain than polished grain with the above images and the following texts.

"Dietary fiber from whole grains, as part of an overall healthy diet, helps reduce blood cholesterol levels and may lower risk of heart disease. Whole grains are sources of magnesium and selenium. Magnesium is a mineral used in building bones and releasing energy from muscles. Selenium protects cells from oxidation. It is also important for a healthy immune system" (United States Department of Agriculture, 2005).

Figure 6 A picture contained in Ha's (2006) article in *Chosun-Ilbo* featured GBR as a functional food. A woman with a skinny waist is looking at a full rice bowl. With the image, the claimed health benefits of GBR to induce weight loss are spread to the lay public.

Figure 7 Advertisements of two GBR-making rice cookers. Above (a) A Korean company's website lists biomedical information about the healthy effect of GABA starting from "increasing the metabolism of neuronal cells and thus improving memory" to "preventing and lessening climacteric, menopausal and pre-senile disorders." Below (b) A web advertisement of a Zojirushi (a Japanese brand) rice cooker is targeting the US. health-concerned consumers. "GABA-brown rice function" is used as a marketing point.

Figure 1. Ratios of nutritional volumes of pre-germinated brown rice compared with those of polished rice level indicated on the dotted line



Source: Kayahara and Tsukahara (2000)

Figure 8 The above graph emphasizes greater increase of GABA in GBR compared to white rice than any other components such as fibers or iron. The graph provides the attendants in the FAO Rice Conference with the impression that GABA-enrichment is one of the most significant changes occurring to rice after germination.

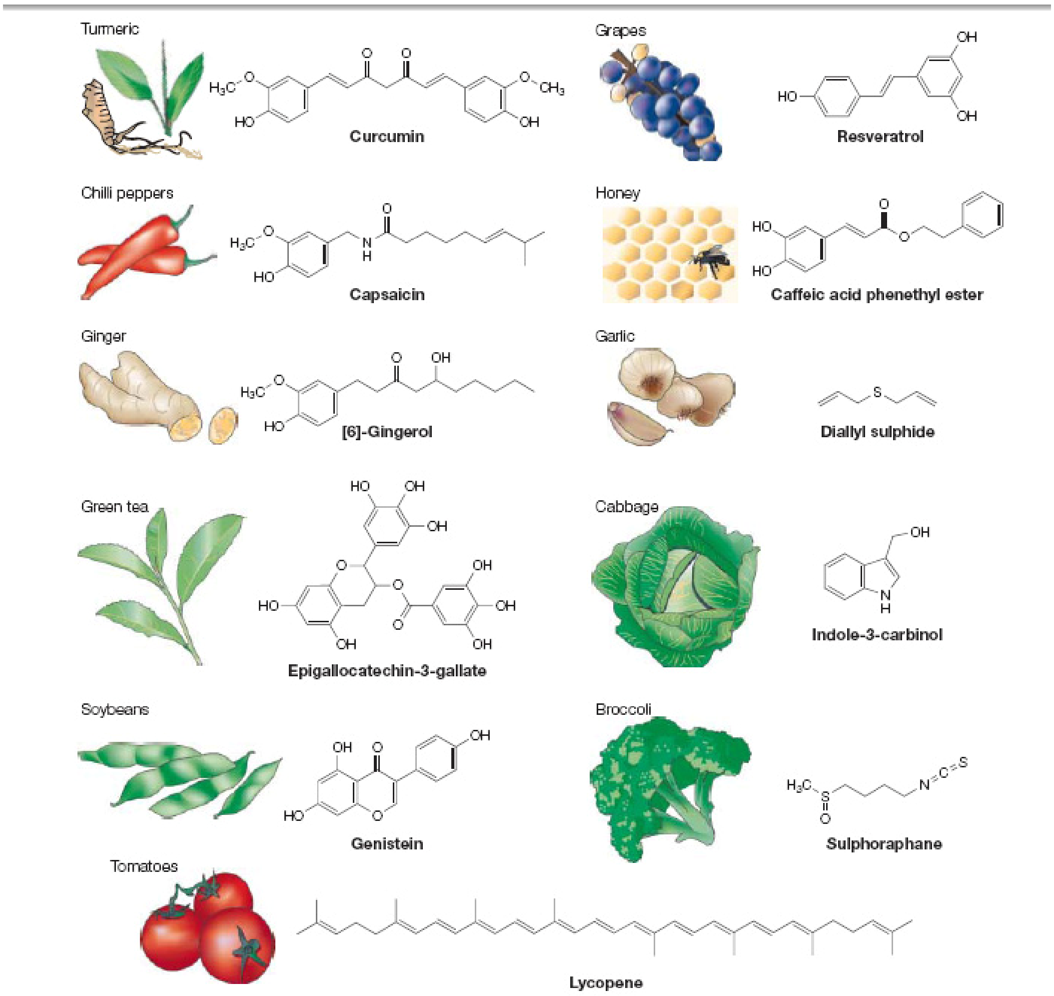


Figure 2 | **Representative chemopreventive phytochemicals and their dietary sources.**

Figure 9 Food scientists also present functional foods with their molecular bioactive components. A readiness to perceive molecules in foods becomes more vivid through popularization of scientific knowledge.

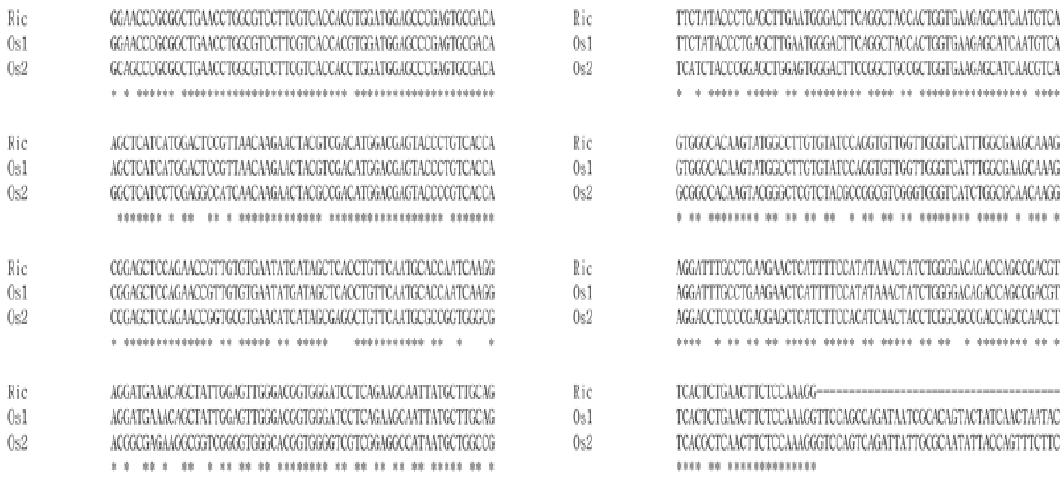


Fig. 1. Alignment of the entire nucleotide sequence (A) and the active site amino acid sequence (B). Ric, Os1 and Os2, *Oryza sativa* (Ric, this study AY428025; Os1, AB56060 and Os2, AB56061); Nt, *Nicotina tabacum* (AF020424); Ph, *Petunia hybrida* (L16797). Gaps are marked by hyphens. Bold letters indicate the sequences of the RT-PCR primers (A) and the consensus motif for the binding of pyridoxal 5'-phosphate (B).

Figure 10 The captured image is from Oh's (2005) research article reporting the entire nucleotide sequence and the active site amino acid sequence of GAD (an enzyme which catalyzes the production of GABA) gene in rice. The cloning of rice GAD gene was an outcome of directed readiness to focus on GABA in GBR. In turn, the sequences deposited in the genebank database will mediate further research on GBR in molecular and genetic level.

Figure 11 Images used in GBR commercials emphasize GABA as its major molecular bioactive components. Above left (a) Brown rice with GABA is punching stress (i-ra-i-ra) in a Japanese GBR advertisement. Above right (b) The picture in another Japanese GBR advertisement points out that GBR is enriched with approximately three times more GABA than regular brown rice, and ten times than those of white rice. Below (c) The picture in a Korean GBR advertisements locates the text "GABA effect" at the center and lists claimed health benefits of GBR—such as lowering blood pressure and reducing the level of triglyceride—around it.

Figure 12 (Above left) The rice cooker sold in Korea germinates brown rice before cooking. (Above right) The image was captured from a TV commercial of a Korean rice cooker. It shows that the cooker can sprout brown rice. (Below left) The sprouter/fermentor made about $30 sales in 2006 in Korea. (Below right) GBR-containing facial cleansers made about $15 million annual sales.

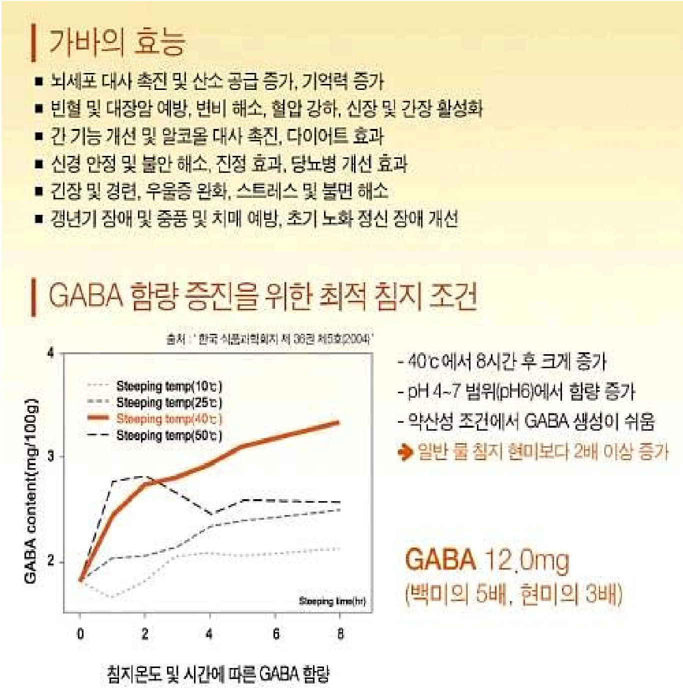


Figure 13 An advertisement on the GBR-making rice cooker company's web, produced upon the knowledge of food science research, shows biomedical information about the healthy effect of GABA starting from "increasing the metabolism of neuronal cells and thus improving memory" to "preventing and lessening climacteric, menopausal and pre-senile disorders".

Figure 14 Pictures of GBR-using recipes in a woman's glossy magazine. The green and brown colors emphasize the image of GBR as a natural food. The pictures show green colors of herbs wrapping or decorating GBR, bamboo dishes and wooden spoons or chopsticks. The recipes suggest consumers to associate GBR with "natural" images as well as with the bioscientific information.

Figure 15 A TV advertisement of another GBR-making rice cooker shows a mother making various dishes (such as GBR sushi decorated with little flowers and herbs) for her family. In the TV advertisement, the mother model narrates, "Because [we] love our bodies, because [we] love our family, mothers use Cuckoo (the brand name of the GBR cooker). Bodies are satisfied [with GBR]." The narratives that mothers should become good mothers by behaving correctly– i.e., giving the healthy rice to her family—and they can get some help from the industrial products are completed in the nostalgic images of bucolic houses, green and brown colors in the pictures of GBR. All these connections of GBR to female consumers made by advertising texts/images actively construct the network of natural image, rice, science, and a proper mode of behavior for health—or GABA, GBR, and good mothers' preparation of GBR.

Figure 16 The above pictures were taken by a Korean housewife and were posted on her blog. Here she not only repeats the protocols suggested by women's magazines but also presents the detailed procedures performed by herself. Her camera focuses closely on the germs budding from the rice. All of the pictures have her blog web-address at the bottom to indicate her role as an author of new information explicitly.

Figure 17 The images are from a GBR-making cooker, featuring the word “GABA”, “brain”, and the narration of “for your smart kids.” In this TV commercial of a GBR cooker, a mother model narrates “Change [your rice cooker], if you are in love [with your child]. [This is] a smart rice cooker for a smart child.” In the next frame, where her daughter is eating rice, the caption reads “good for brain, GABA: use GABA-brown-rice making function and GABA will increase a lot after 8 hrs [of soaking] in 40°C, pH 6 [water].” The mom model kisses her daughter and says again. “Be a good mother.” Whilst GBR advertisements inform consumers the biomedical information, it also encourages mothers to become managers of family members’ health.

Figure 18 Pictures were taken by female bloggers after they made GBR from scratch (left) and using the GBR cooker (right). In both cases, the bloggers posted their own articles with the pictures. Typically, such blog articles express GBR consumers' understanding of the GBR's health-effect and what they think of their responsibility as mothers and health-managers.

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NOTES

Transcriptions of Korean words follow the new Romanization system throughout the dissertation except for Korean authors' names of the individuals' choice. Citations follow the publication manual of American Psychological Association (APA). Korean texts were translated by the author.